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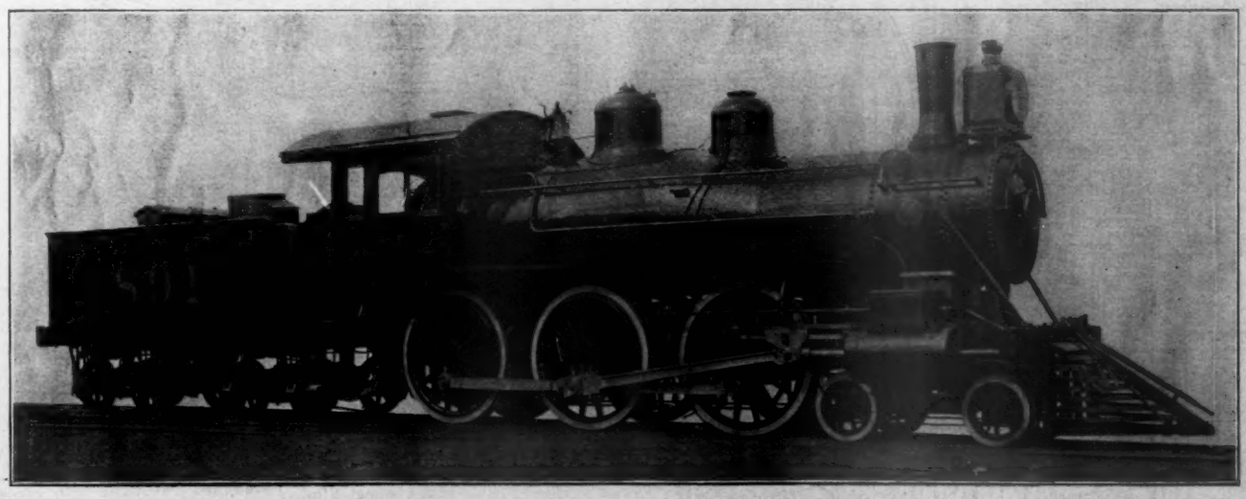
Ten-Wheel Passenger Locomotive—A., T., & S. F. Railway.

By The Dickson Manufacturing Company.

Through the courtesy of Mr. John Player, Superintendent of Machinery of the Atchison, Topeka & Santa Fe Railway, and of The Dickson Manufacturing Company, we are enabled to show our readers some of the chief features of the design of 10-wheel passenger locomotives, of which eight are now being built for that road.



Ten-Wheel Locomotive—Atchison, Topeka & Santa Fe Railway.

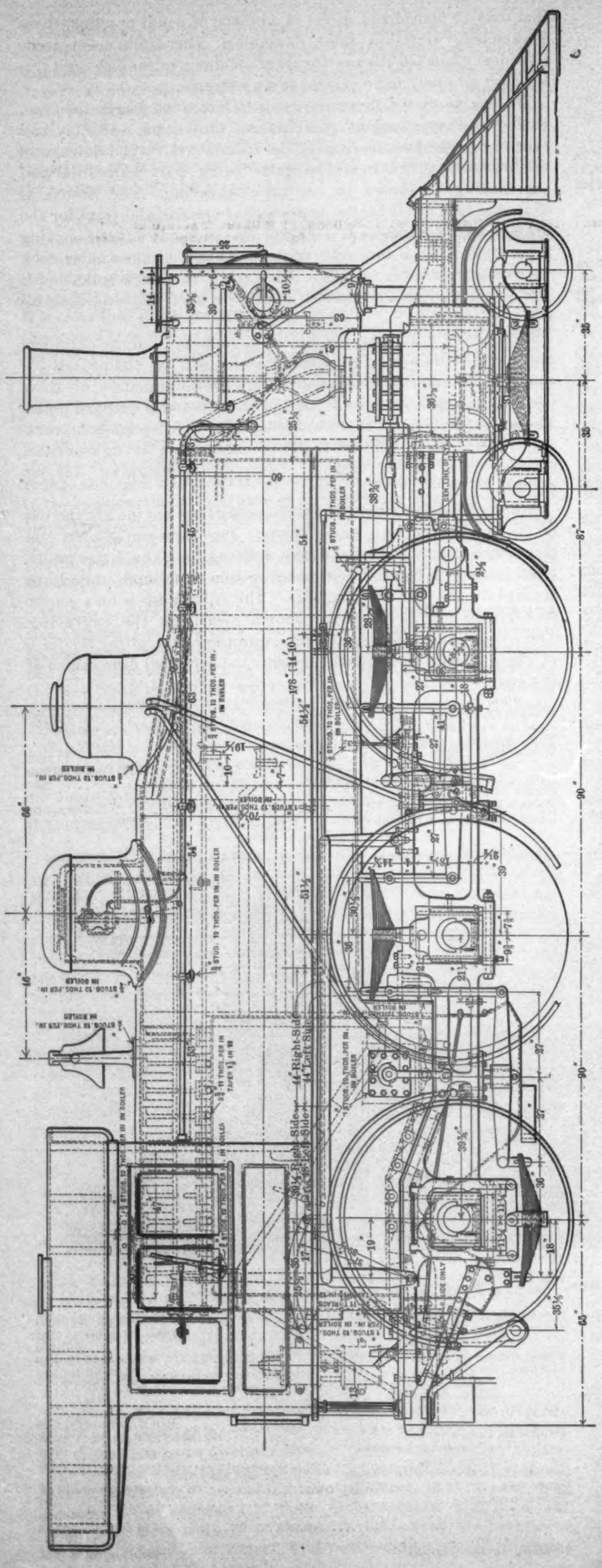
The design was prepared by Mr. Player, and from the excellent reports received from the new freight engines built by the road at Topeka, it is fair to expect that the passenger engines will be very satisfactory. The officers of this road believe in large heating surface with a moderate size of grate, the ratio between the heating surface and the grate area being 86 to 1, which is unusually large. It is interesting to note that the corresponding ratio for the 10-wheel passenger compounds for the Northern Pacific, described in our June number, is 81 to 1, and that for the Monon 8-wheel passenger engine, shown in our August number, is 70 to 1. It is clear that the tendency toward larger heating surfaces is growing. A ratio of 106 to 1 is now in use, and while that may be considered as far in advance of usual practice, there is a tendency to follow these examples. There also seems to be a tendency toward the use of rather smaller grates, although this is not at all likely to be carried to an extreme.

The engine under discussion is of the extended wagon-top type, with the Player patent combination crown bar and stay-bolt type of crown-sheet staying. The frames are forged down and the firebox is above them, the grate being part horizontal and part sloping, as shown in the large engraving. The firebox is 88 inches long by 42 inches wide, a good comfortable size for the fireman to cover well. The engine has a grate of the rocking type, a brick arch supported on water tubes; it has a short deck with diagonal braces from the frames to the back boiler-head. The air pump is placed under the cab, back of the engineman's seat.

The driving wheels are 73 inches in diameter and the cylinders are 19½ by 28 inches. The steam pressure will be 180 pounds per square inch, and it is evident that with the combination of these parts the large boiler will be found very useful on hard pulls. The weight on drivers is 110,000 pounds, or 18,300 pounds on each driver; the total weight is 143,000 pounds, which is lighter than the Northern Pacific engines referred to, weighing 155,500 pounds.

Among the other noteworthy features of the engine are the use of the Rushforth feed-water heater, the Houston sander, the large capacity of the tender tanks, 4,650 gallons, the Laird guide, long, guided valve rods, extended piston rods and underhung springs for the rear driving axle. The equalizing is on a combination plan and its details are shown clearly in the engraving. The tender tank is unusually large and the frame of the tender is of steel. The following table presents the principal dimensions of the engine:

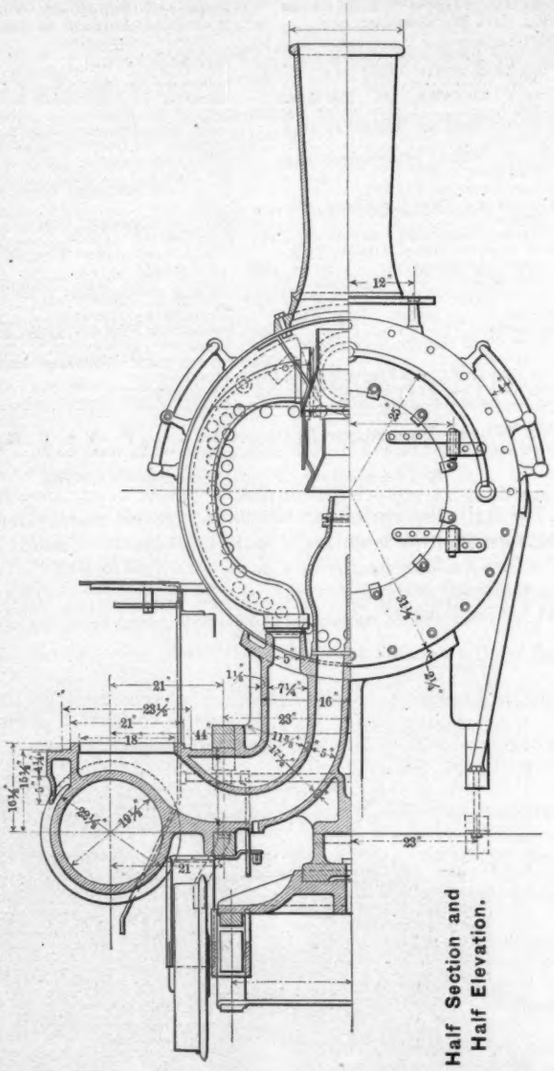
Fuel.	Bituminous coal.
Weight on drivers	110,000 pounds
" truck	30,000 "
Total weight	140,000 "
Wheel base, rigid	15 feet
" " total	25 feet 2 inches
Length in all, engine and tender	55 feet
Boiler, type	extended wagon-top
Working pressure	180 pounds
Diameter barrel, smallest ring	60 inches outside
Thickness of material in boiler	⅛-inch, 9/16-inch and 5/8-inch
Seams, horizontal	quadruple butt joint
" " circumferential	double
Dome, diameter	30 inches
Firebox, length	88 inches
" width	42 "
" depth, front	64⅛ "
" " back	58 "
"	brick arch on tubes
Thickness tube sheet	½ inch front, ⅜ inch back
" side and back sheet	⅜ inch
" crown sheet	½ inch
Crown sheet stayed with Player crown bar and stay.	
Grate bar	cast-iron shaking
Tubes, number	264
" diameter	2 inches
" length	14 feet 10 inches
" gauge	No. 11 W. G.
Heating surface, tubes	2049.5 square feet



TEN-WHEEL LOCOMOTIVE—ATCHISON, TOPEKA & SANTA FE RAILWAY.

JOHN PLAYER, *Superintendent of Machinery.* DICKSON MANUFACTURING CO., SCRANTON, PA., *Builders*; C. H. ZEHNDER, *President.*

Heating surface firebox	146.5 " "
" " total	2196.0 " "
Grate area	25.5 " "
Cylinder, diameter	19½ inches
Piston stroke	28 "
" rod, diameter	3¼ "
" " packing	Jerome metallic
Valve	Richardson Balanced
Driving wheel, diameter	73 inches
Truck " "	30 "
Journal driving axles, size	8½ inches dia., 10 inches long
" truck " "	5½ inches dia., 10 inches long
Main crank pin.	6 inches dia., 6 inches long; 6¼ inches dia., 5 inches long.
Back and front crank pin	5½ inches dia., 3¾ inches long
Smokebox, diameter	63 inches
" " length	61 "
" stack, smallest diameter	11½ "
Exhaust nozzle	Single
Sand blast	Houston



Half Section and Half Elevation.

Feed-water heater	Rushforth
Reed cyclone blow-off cock.	
Tender frame	steel, 9 inches deep
" truck wheel, kind	Standard wrought iron center steel tire
" " " diameter	30 inches
" " axle	4¼ inches dia., 8 inches long
Tank capacity for water	4,650 gallon
Length of tank	19 feet 9 inches
Width of tank	9 feet 1 inch
Height of tank, not including collar	4 feet 8 inches
Material in tank, thickness	¼ inch and 5/16 inch

A good crop and a place to put it is sure to make railroad business good. We are informed that during a single day in early September over 5,000 car loads of grain were landed in Chicago, and that 37 trains with a total of 1,220 loaded cars of grain were dispatched from Galesburg, Ill., to Chicago in a single night over the Burlington road.

Pintsch Gas Tanks in a Wreck.

On page 346 of this issue, a brief statement is made with regard to the alleged explosion of Pintsch gas tanks in the wreck which occurred on the Rio Grande Junction Railroad, September 10. It was stated that an explosion of a gas tank under one of the cars caused the fire which added to the horrors of the disaster. No one who gives the subject thoughtful attention will cousider such a claim, but in order to show that this is not a mere matter of opinion in this case we publish in full a report, received since the above-mentioned paragraph was written, upon the condition of the gas tanks based upon an examination that was made after the wreck. This is signed by Mr. C. H. Quereau, a disinterested person, as well as by Mr. Schlacks and Mr. Hooper. The names of Mr. Schlacks and Mr. Quereau used in this connection will satisfy all who know them. There is evidence to show that some sort of an explosion occurred after the wreck, but that the gas tank did not explode is established by this report, which we reproduce verbatim as follows:

DENVER, COL., Sept. 20, 1897.

To the Denver & Rio Grande Railroad Co., Denver, Col.:

GENTLEMEN: We were this day requested to examine the tanks that were loaded on D. & R. G. coal car No. 15,214, being shipped in this car from the place of accident to Denver, and are, as we understand, the Pintsch gas tanks removed from the recent wreck at New Castle.

We saw these tanks unloaded and brought to a platform near your storehouse at Burnham, and the nine tanks were marked from one to nine, also the date 9|20 and the number of the car 15,214 being marked on with paint on the ends of these tanks.

Tank No. 1. Heads good; body badly bent; all rivets intact.

Tank No. 2. This tank is not dented and rivets all in place.

Tank No. 3. Both heads good; body slightly dented; rivets in place.

Tank No. 4. Both heads good; body dented very little and rivets good.

Tank No. 5. One head slightly dented and one good the body dented badly; rivets all in place.

Tank No. 6. Nearly perfect; some slight dents in body and three screw-bolt heads knocked off; apparently knocked off after fire.

Tank No. 7. Nearly perfect, with the exception of one bolt head on one of the heads broken off; apparently done before the fire.

Tank No. 8. Very badly dented and bent; one of the heads dented and small hole ½ inch long by ¼ inch wide knocked in it; rivets and bolts all in place; one head good.

Tank No. 9. Badly bent and out of shape in middle; heads good; all rivets in place and seem to be good; no indication either on body or heads of a rupture.

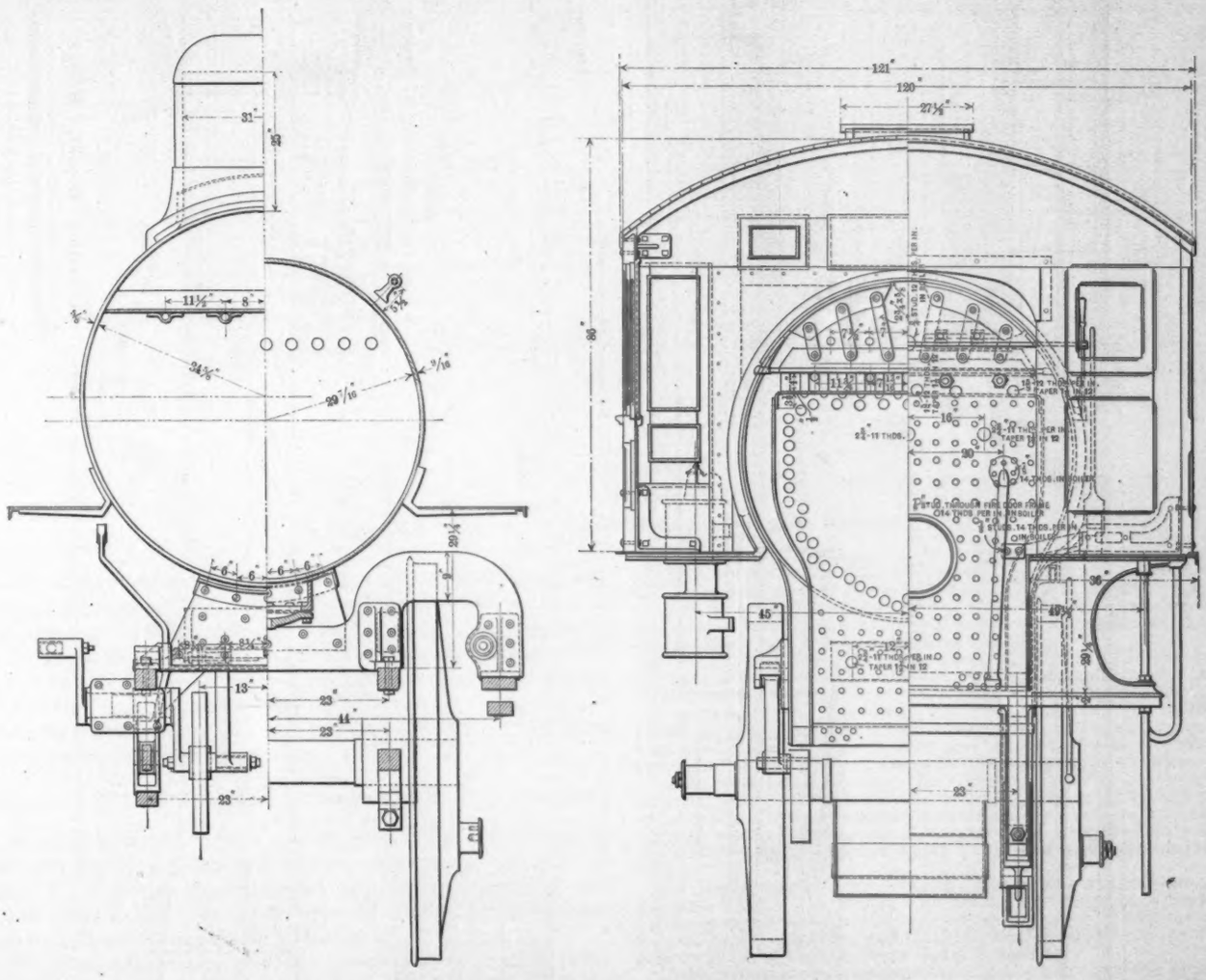
All these tanks had the appearance of going through the fire, and were more or less bent, dented and burnt; and on account of the excessive heat, the solder in the joints was melted out and they were more or less warped; but on none of these tanks, no matter how hot they seem to have been, or whatever strain they were subjected to, on account of parts falling on them, there is not the slightest indication of an explosion; and we can state without hesitation that these tanks were not exploded at the wreck or anywhere else; and from all appearances, they were in first-class condition before the accident.

They are the tanks furnished by the Pintsch Gas Company, and the mechanism of these tanks is first-class.

(Signed) Henry Schlacks,
Superintendent Machinery.

W. H. Hooper,
Representative Pintsch Gas Company.

C. H. Quereau,
General Foreman, B. & M. R. R. R.



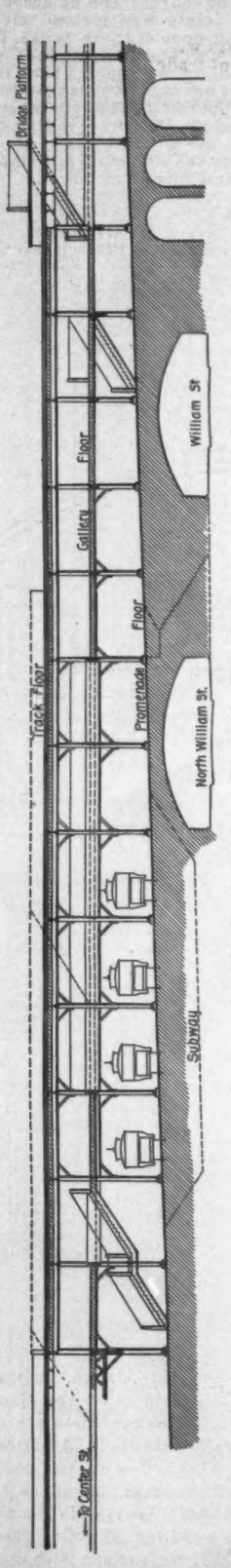
Ten-Wheel Locomotive—Atchison, Topeka & Santa Fe Railway.

Information recently received from Tokio, Japan, indicates that the Japanese government have finally adopted for the 180 miles extension of the Imperial Railway, for which contracts are about to be awarded, the 60-pound section rails, known in America as the Pennsylvania Railroad standard. This action on the part of the Japanese government should be to the advantage of the American mills, as the English sectional standard previously employed requires special rolls and additional handling of rolls. The choice was made, it is said, after close expert comparison with the English standard and with all the standards in use on the principal rail ways in the United States.

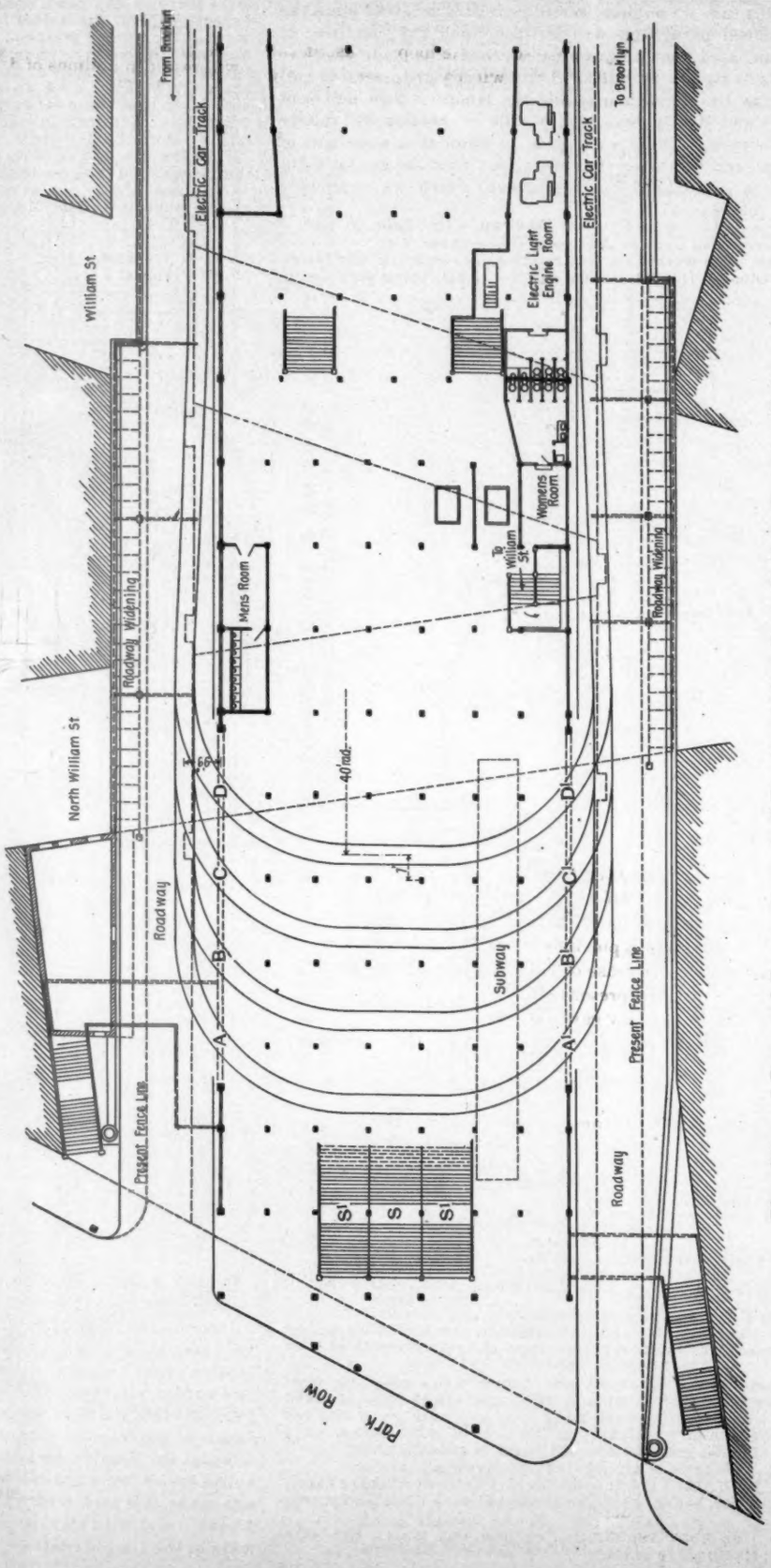
Electric Cars and Elevated Trains on the Brooklyn Bridge.

The admission of the electric cars and elevated trains from Brooklyn over the Brooklyn Bridge, the contracts for which were signed recently, will necessitate a rearrangement of the tracks at the New York terminus and somewhat of a change at Brooklyn for the connection of the rails of the street lines. It was originally intended to provide for the electric cars at the New York end of the bridge by means of an additional deck, to be erected over the present platform. This idea, however, has been abandoned for a much more simple one.

At the Brooklyn end cars will come upon the bridge over Washington street, and in leaving the structure they will cross the Plaza to Liberty street, and this will not require much difficult work, if the present plans are carried out. The changes at the New York terminal are more extensive and our engravings



Longitudinal Section Through Terminal.



Plan View of Proposed Rearrangement of Tracks at New York Station, Brooklyn Bridge.

show in a general way how the new arrangement will be accomplished. The electric cars will come in from Brooklyn over the track shown at the upper side of the plan view and passing around one of the four tracks of the loop will come upon the return track ready for passing over the bridge again. In order to lay these tracks portions of the present brick wall will be removed, as shown by the dotted lines. A plan has been formulated for the operation of the tracks, and if carried out four cars will stop on the curves at the entrance of the loop, one car being on the curve approach to each cross-connection. They will unload here and simultaneously move across the loop tracks, at the other ends of which they will load and will pass out successively for the return journey over the bridge. A subway is provided so that passengers need not cross the loop tracks in taking or leaving cars. The location of this may be seen in the drawings.

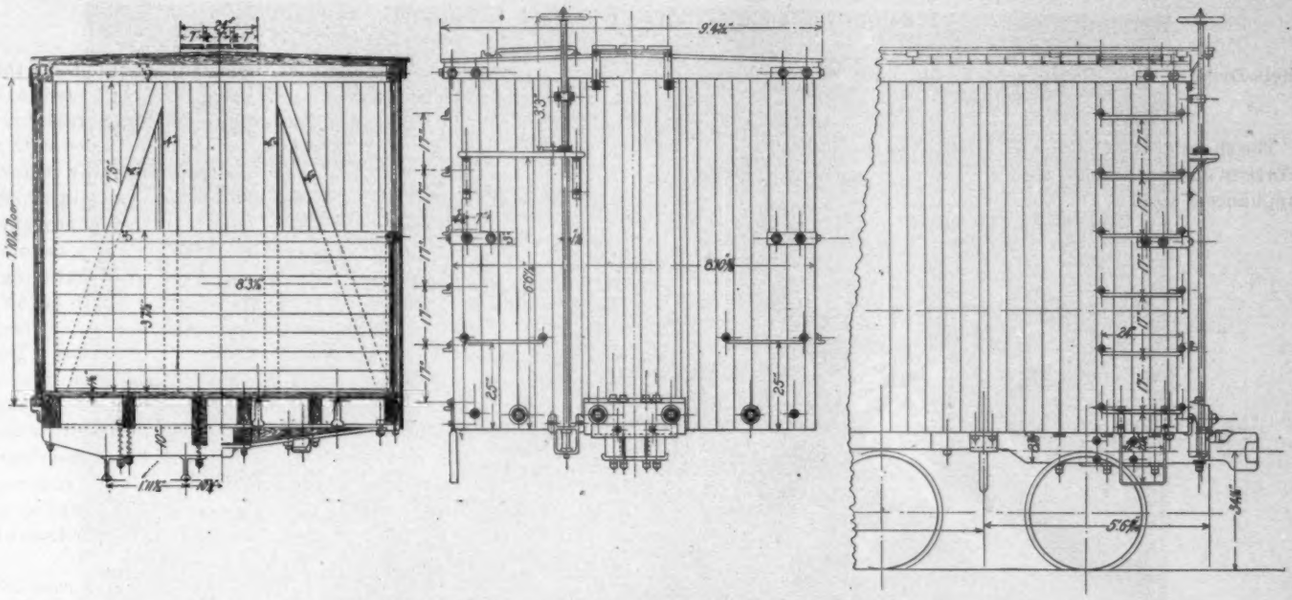
It has been decided to place the trolley cars in the roadway of the bridge on each side of the present bridge car tracks. The location of the new tracks was an interesting problem, and it is believed that this will give the best distribution of loads upon the supporting cables. The effect of the changes of the method of operating the bridge will doubtless, be to greatly increase its capacity, and after this plan is put into effect it is difficult to see how provisions for further increase of traffic can be made. It is the intention to continue the present bridge trains, but it seems questionable whether the trolley cars will not deprive them of a large part of their present business.

Box Cars Without Carlines—Chesapeake & Ohio Railway.

In reply to a number of inquiries concerning the method of construction of box cars without carlines, designed and built by Mr. W. S. Morris, Superintendent of Motive Power of the Chesapeake & Ohio, we present the accompanying illustration taken from a drawing kindly furnished by Mr. Morris.

This design is for cars of 60,000 pounds capacity, their peculiarity being a construction of the roof wherein carlin sheathing takes the place of the usual carlines. The object is to give greater cubical capacity to the car. The plan was first used in building furnishing cars and gave 250 cubic feet of additional space available for loading without any change in the outside dimensions of the car. There are now about 400 of these cars in use, some of which have been in service for more than five years, and Mr. Morris states that they have given very satisfactory results and no failures of the roofs have been reported.

The method of constructing the roof and its appearance outside and inside will be understood from the engraving. The carline sheathing is 6 inches wide. It is tongued and grooved and is 1 inch thick at the ends and 2¼ inches thick at the center. The sheathing is separated from the roof boards by roof felting, as shown in the drawing.



Box Cars Without Carlines—Chesapeake & Ohio Railway.

Opening for American Enterprise in China.

Consul Read, of Tientsin, has transmitted the following letter to the State Department from Messrs. Taylor & Company, of Tientsin, China:

China, in the next few years, will be a buyer for all classes of machinery, and especially railway materials. It has been demonstrated that America has chances as good as those of any other country to secure orders.

If our American manufacturers will make the proper efforts it will result in millions of dollars of trade.

A commercial representative should be selected, care being taken that he has influence in the proper quarters, which, as you know, is absolutely essential. This representative should be the sole agent in the East. He should be authorized in the proper form, as are the representatives of European houses, with the seal of the foreign office; and his name should be registered here in the consulates.

In the construction of a railway the Chinese require rails, sleepers, couplers and structural iron for bridges and locomotives. If the best houses in America will place their respective business interests in the hands of one good business firm in Tientsin, this firm can bid for everything wanted, will appear strong in the eyes of the Chinese, and each transaction will, perforce, strengthen the mutual business relations between America and China.

If we may be allowed to do so, we would advise that you lay all we have to say before the officials of the Department of State at Washington, with the suggestion that they call the attention of our manufacturers of railway materials, including the Westinghouse Air Brake and Wharton Switch companies, and manufacturers of firearms, locomotives and men-of-war to the existing opportunities for doing business in this section of the world.

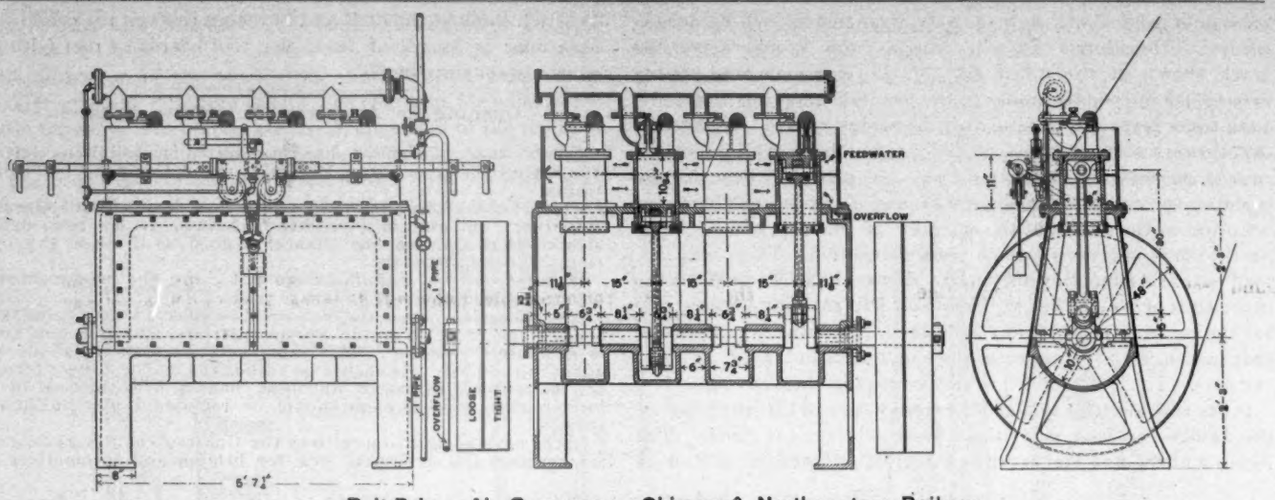
We have information that the Chinese Emperor has issued an imperial edict authorizing the purchase of six first-class battle ships, six first-class cruisers, six second-class cruisers, and twelve torpedo boats. The Chinese Government is going to create a loan of 100,000,000 taels, a part of which will go toward purchasing the vessels.

His Excellency Li Hung Chang (who is now at the head of the Tsung-li-Yamen), in recognition of the assistance of America in bringing about peace in China's war with Japan, is anxious to do something for America, and if there is half a chance we can secure a large share of this business, for that reason.

There will be an enormous trade done here within the next few years, and if America can gain her part, it will mean additional labor to thousands of our workingmen and the bringing to our country large returns in profits to manufacturers.

Unfortunately, America has suffered by the class known as adventurers and fortune-hunters, who have no visible means of existence and who come to China willing and anxious to advance or accept any visionary scheme that offers the least prospect of success—schemes that no business man would have anything to do with, and each failure sets American interests further in the rear.

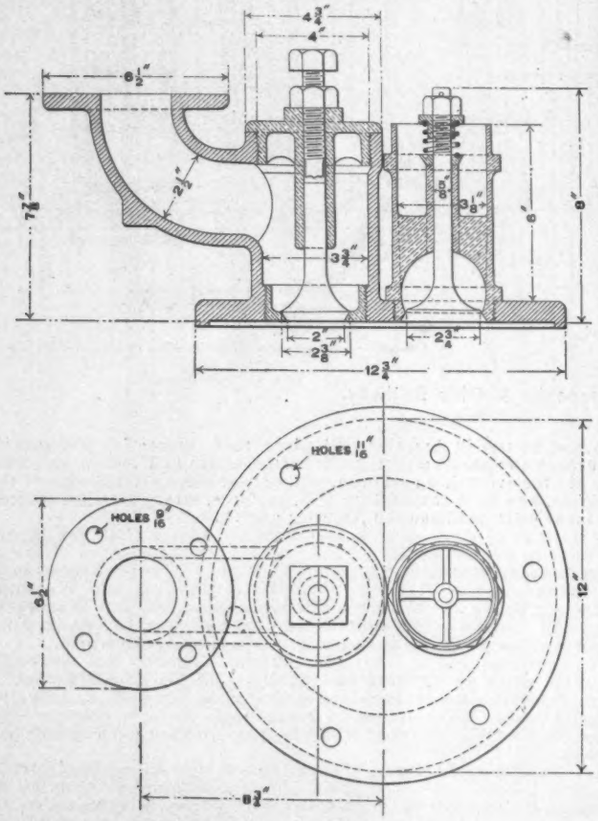
Mr. Read speaks of the presence in China of Mr. C. D. Jameson, representing the Baldwin Locomotive Works, of Philadelphia. It seems that Mr. Jameson made a contract with the Chinese government for four locomotives to be delivered at Tangku on or before June 30, 1897; also, for eight locomotives to be delivered between July 20 and Sept. 20, 1897.



Belt-Driven Air Compressor—Chicago & Northwestern Railway.

Belt-Driven Air Compressor, Chicago & Northwestern Railway.

The shops of the Chicago & Northwestern Railway, at West Fortieth street, Chicago, are well equipped with compressed-air appliances, and having found it necessary to add to the compressor plant the belt-driven compressor shown in the accompanying engraving was designed and built at these shops.



Belt-Driven Air Compressor.

The compressor is single-acting and has a crank case for the purpose of running the cranks in oil, after the plan of the Westinghouse engines. The air-admission valves are placed directly on the tops of the cylinders, as will be seen by the engraving. The clearance is small, which is an important point not always considered in air compressors built by non-professionals, and in this particular the design under consideration is worthy of favorable comment. The space between the piston in its uppermost position and the cylinder head is only $\frac{1}{64}$ inch. The construction of the valves may be seen in the sectional view. The inlet and outlet valves for each of the four cylinders are mounted on the cylinder-head castings, and the outlet valves are connected to a cast-iron manifold discharge pipe leading to the storage reservoir.

The cylinders are of cast iron, and by being provided with a flange connection for bolting to the crank case are easily removable. They are surrounded by an open-topped casing in which cooling water circulates, a horizontal diaphragm being provided in order to secure a current of water about the cylinders, as indicated by the arrows in the central view of the large engraving. The stroke of the pistons is 10 inches and the length of each cylinder above the pistons in its lowest position is $10\frac{1}{64}$ inches, which emphasizes what has been said about the clearance. The pistons are $5\frac{1}{8}$ inches deep and are cast with bosses to receive the wrist pins with which the connecting rods connect. Holes are drilled through the pistons for the purpose of inserting the pins. The packing is double, in the form of $\frac{3}{8}$-inch cast-iron rings. For the lubrication of the cylinders annular oil cups are secured to the bottom ends of the cylinders in such a way as to allow the pistons to dip into them at their lowest positions at each stroke.

As shown in the front elevation, the sides of the crank case are removable for the purpose of getting at the cranks and rods, and with a few minutes' work the whole machine may be readily uncovered for repairs. The governor is so arranged that when the pressure at which it is set is reached the belt is shifted from the fast to the loose pulley by means of air pressure admitted to the governor cylinder. When the pressure in the reservoir decreases the air escapes from the governor cylinder and the weight shown in the illustration shifts the weight to the driving pulleys again. The fixed pulleys have heavy rims in order to enable them to act as flywheels. The compressor is nearly 7 feet high, and about 9 feet wide over all, the depth being 48 inches, or the diameter of the flywheels.

This machine was designed for use in the car department shops where the steam power is derived from the burning of refuse such as shavings from the car work. The arrangement is compact, and it admits of easily renewing parts that may become worn in service. We are indebted to Mr. Robert Quayle, Superintendent of Motive Power, for the drawings.

A recent communication from Consul J. C. Monaghan, written at Chemnitz, with regard to Prussia's railroad earnings, states that more than half Prussia's income is derived from the railroads.

An English contemporary states that the corporation of Blackpool has resolved to abandon the underground electric conduit system in favor of the overhead trolley. This was one of the first electric railroads in the United Kingdom. The reason for the change is the high cost of maintenance of the conduit equipment.

The Works of the Peerless Rubber Manufacturing Company—New Durham, New Jersey.

The importance of the industry of manufacturing mechanical rubber goods is a subject with which our readers are thoroughly acquainted, and we feel sure that the following description will be interesting. There has been a great deal of misunderstanding and somewhat of mystery about the manufacture of rubber, and through the courtesy of Mr. C. H. Dale, President of the Peerless Rubber Manufacturing Company, of 16 Warren Street, New York, we are enabled to illustrate and describe the process as practiced at the works of that company, at New Durham, New Jersey, a short distance from New York City.

The basis for all ordinary rubber goods is the sheet of rubber, and when it is necessary to furnish strength to resist tearing, bursting or tension stresses canvas is incorporated in the structure. In Mill No. 3, which is a new equipment, this process may be seen to the best advantage. There are three separate mills, and the other two will be referred to again. Mill No. 3 is the starting point for nearly all of the crude rubber, though the preliminary process may also be carried out in the other mills when necessary. The building is 219 by 35 feet, and has two stories. It is the most modern plant of its kind in the country, and was fitted up regardless of expense, the primary object in view being to put in a plant for the purpose of making the best of rubber goods. The power is derived from a 300 horse-power Watts-Campbell, Corliss 24 by 40 inch engine connected with the main shaft by large spur gears. The engine is at the center of the mill, and a line shaft runs along under the floor to both ends of the building. The mills and calenders are geared direct to this shaft, and no belts are used. The machine work was done by the Farrel Foundry and Machine Company, of Ansonia, Conn., and it was well planned and executed.

At one end of the building the crude rubber as it is received from Para in the form of large lumps of irregular shape is washed in a tank of hot water for the purpose of removing the loose dirt. The washing is completed in a washing grinder, consisting of one smooth and one corrugated roll. The rubber is washed with hot water while in this machine, and here it takes an irregular sheet form about three-quarters of an inch in thickness. It is still porous and rough, and after thoroughly drying in the drying room overhead it is ready for the grinding or "breaking down." This process is carried on in grinding rolls or calenders heated by steam. The rubber is put into a smooth sheet form, and after being sufficiently "worked" it is ready to receive the "compounds" which are used to prepare it for the special purpose intended. The hose material is compounded differently from that used for making packing, each purpose requiring different compounds, which are all minerals, and the secrets and the skill of the trade are chiefly in the selection and proportioning of the ingredients used in this compounding. The ingredients are weighed out and incorporated into the rubber on the mixing grinders.

One of our illustrations shows a grinding machine alongside of one of the large calenders. Two horizontal rolls are carried in heavy housings, and the boxes are adjustable for the purpose of putting more or less work, as desired, on the rubber.

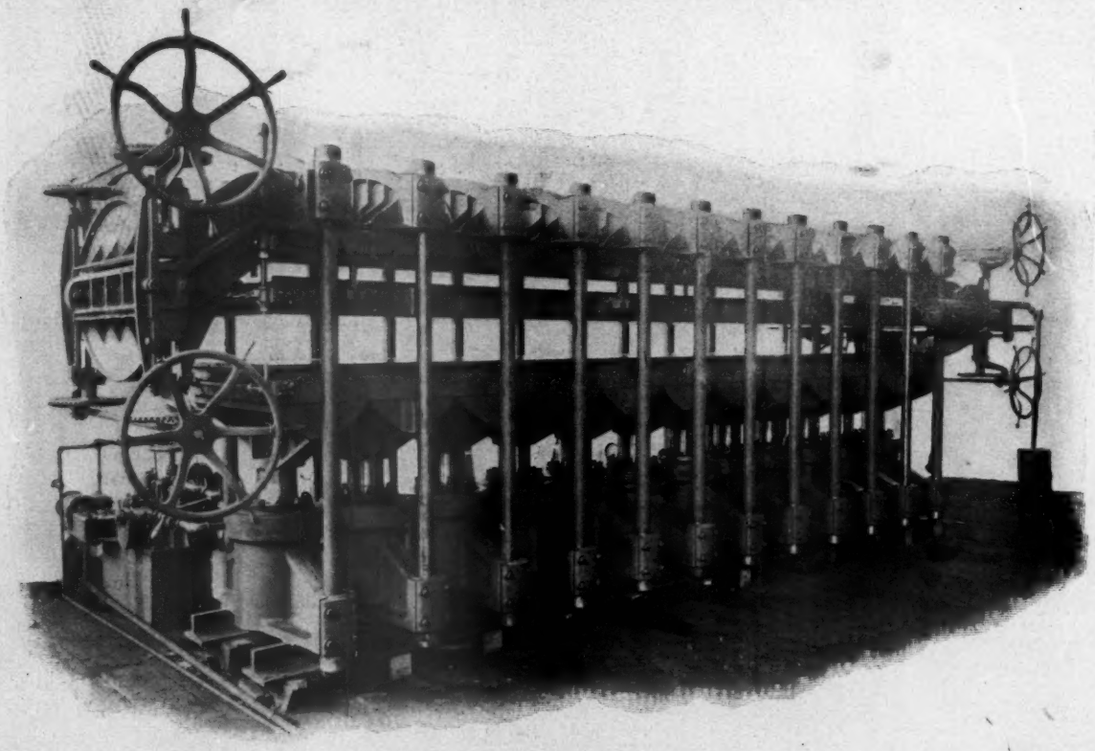
After the mixing the rubber is "batched out" on a bench at the rear of the machines, and it is there piled in slabs of irregular shape ready for the next process. That which goes to make packing, gaskets or other similar specialties goes to Mill No. 1. That made for belting or hose is further treated in Mill No. 3 as follows: For belting and hose, duck must be used, and it must be coated and thoroughly impregnated with rubber. This process is carried out on the "friction calender." The rubber used is prepared of the proper thickness on the "sheeter," the three-roll calender shown. These calenders will be referred to again. The sheet is rolled out and is given the proper width by stops, one of which is seen near the left-hand end of the two upper rolls. The duck is prepared in the "friction calender," which differs from the sheeter only in that the middle roll of the friction machine turns one and one-half times as fast as the top and bottom rolls, while the velocity of the three rolls of the sheeter is uniform. The center roll of the friction calender is covered by an envelope of sheet rubber about one-eighth inch thick, and the duck is pressed against the rubber on the hot roll, the difference in the speed of the duck and the rubber causing the rubber to be squeezed entirely through the duck. The friction process is applied to both sides of the duck, and then it may be coated on either side with a sheet of rubber which will readily adhere to the friction duck, and is then ready to be incorporated into a rubber structure al-

The Hose Department.

most as if it was itself rubber. This friction duck, after receiving a coating of rubber on one side, is the basis of belt and hose making.

In the belt room there are four zinc-topped tables; two of them are 120 feet long each and one is 100 feet long, the fourth being 80 feet long. The belts are laid out here, the friction duck being followed up over a filler strip into the required number of "ply," and the continuous or other kinds of belts that are stitched are put through the large sewing-machine shown in the foreground of the engraving. The stitches are in seams one inch apart. After the completion of the folding of ordinary belts the cover is put on the belt and it is ready for stretching and vulcanizing. Belts 50 inches wide are made in this way. The stretching and vulcanizing are done on a large hydraulic belt press. This press has three plates heated by steam and moved toward each other by 12 hydraulic plungers upon which the bottom plate rests. The stretching is done between the stationary clamp at one end of the machine and the clamp at the other end which is carried by the plungers of two horizontal hydraulic cylinders. The heat of the steam in the plates does the vulcanizing, and when the belts have been stretched and pressed under the action of the high temperature, they are complete and ready for service. In the belt room small belts are made by machinery, which may be seen indistinctly at the right in the view of this room. Here the belts are folded, and completed by passing through rolls. In this way a man and a boy can together make about a mile and a half of 1½-inch belt per day. In this illustration a vacuum brake diaphram is seen in process of making at the left of the sewing-machine.

The Belt Room.



Belt Press Stretcher and Vulcanizer.

The large calenders and the belt press merit further notice.

They were built by the Farrell Foundry and Machine Company, and are admirable pieces of machinery. It is understood that no limit of cost was placed on them, the builders having carte blanche to build the best possible machines for the purposes.

The large press is a handsome piece of work, as will be seen from the photograph, which was taken at the builders' works. With its foundation it cost $16,000. There are three steam-heated platens for working on two layers of belts at once. The view shows the middle platen supported by links for the purpose of introducing the work. These platens are 50 inches wide by 25 feet long. The 12 hydraulic cylinders are fitted with 10-inch rams with a working stroke of 18 inches. The rams are designed to operate under a pressure of 2,000 pounds per square inch provided by a special geared pump. This pump is seen at the left of the press. It is too slow in operation for moving the plungers when high pressure is not upon them, and an auxiliary Worthington duplex pump is used for moving the platens up to the point where high pressure is to be applied. At each end of the press clamps, already referred to, are provided for stretching the belting. On the front end they are stationary, while those at the rear are carried on the plungers of the two 6-inch hydraulic stretcher cylinders having a stroke of 50 inches. The weight of the machine is 90 tons, its height is nearly 10 feet and its length 34 feet.

line on one side of the engine is 59 feet 2½ inches and the mixer and washer line on the other side of engine 64 feet 9 inches long. The speed of the main shaft is 65 revolutions per minute.

The hose room is in a one-story building by itself. It is 230 by 42 feet in size and is one of the finest hose rooms in the country. It is unusually well lighted and is a decidedly pleasant shop, as the engraving will show. There are 15 zinc-topped tables, 50 feet long by 45 inches wide, and along the right-hand side are two cylindrical vulcanizers, 3½ by 54 feet in size. Five tables are given to air-brake hose, this being one of the favorite specialties of the company. The duck for the hose, which is made specially for this purpose, is most carefully prepared. As stated, after being put through the friction calender it is passed through the sheeter and receives a coating of rubber on one side of the friction coating. This part of the preparation is important, for the rubber will not stick to the duck, but will stick only to rubber. The friction process must therefore be carried out perfectly or the hose is weak. Much hose is weak because some manufacturers slight this work and depend upon artificial means to stick the friction duck together when it is rolled into the hose. The hose duck is laid out on one of the tables, and, for 1½-inch hose, is cut into 22 by 22 inch squares, turned so as to be diagonal with the threads of the duck to

Sheeter, Calender and Grinder Rolls.

The grinder rolls are all 16 inches in diameter by 40 inches long on the face, the speed of the driving roll being 22 revolutions per minute. The space occupied by each machine is about 5 by 9 feet. The washer rolls are 15 inches in diameter by 24 inches long.

The large calender machines are not less admirable than the press. The cost of each of them with its foundation was $8,000. The rolls are 22 inches in diameter by 65 inches face, and each machine has two speeds, one of 7 yards and the other of 10 yards per minute. Each calender, including the driving mechanism, takes up a space of 8 by 20 feet, which shows the large size of the machines. The height from the floor to the top of housings is 9 feet 6 inches and the weight about 35 tons. The rolls of the calenders and grinders are all made of chilled cast iron. The frames, bed plates and general parts are of cast iron the roll journals of bronze and all gears of special metal.

The line shaft, already referred to, has a diameter of 6⅞ inches at the engine end, tapering down to 5⅞ inches at the farthest point away from the engine. The total length of line shaft, including engine jack shaft, is 135 feet 3½ inches; or in other words the jack shaft is 11 feet 4 inches long, the warmer and calender

render the hose pliable. The inner tubes are made by hand, the experience of these people having shown this to be necessary. The tubes are two ply of rubber sheeting that has been previously doubled on the sheeter calender, making four layers of rubber for each inner tube. This sheeting, in the form of 5 by 22-inch strips, is rolled over the proper-sized mandrel, and when the first ply is ready the second is rolled over it so as to break joints with the first. The friction duck is then rolled over the tube, the coated side of the friction duck being against the tube. The union between the inner tube and the coated duck is complete, and in several samples that the writer picked up from a pile of hose on the floor the duck could not be separated from the rubber tube after unrolling the sheet without tearing the rubber apart.

The ends of the wrapped hose are capped, and a cover sheet of rubber is rolled on over the duck. The labels are then put on, the hose wrapped in a cloth envelope, and it is ready for vulcanizing. After vulcanizing it is stripped from the mandrels by air pressure. A nozzle is passed over the end of the mandrel and against the inner tube of the hose. The application of air pressure loosens the hose so that it may be easily drawn off. The vul-

canizing is done by keeping the hose in an iron cylinder filled with steam for the proper length of time. The cloth envelope referred to acts as a mold and tends to produce a smooth, regular surface on the finished hose. The hose is finished when the wrapping is stripped off after the vulcanizing is completed.

The air-brake hose is packed in boxes of 100 lengths, the usual output of the room being 1,400 pieces of 1¼-inch hose per day. Steam hose, corrugated and smooth, suction hose with wire inside, and hose for water is all made in this room, and the processes for all are similar in principle to that already described. About 32 men are employed in the hose room.

Mill No. 1 is the largest of the buildings. It is used for a large variety of work. At the center the small parts, such as gaskets for air-brake pumps, gauge-glass rings, pump valves, bib washers and valve packing are made and vulcanized. On one side considerable space is devoted to "Rainbow Packing," a product that has to a large extent revolutionized methods of packing manhole covers, valve connections and steam joints of all descriptions. Of the "Rainbow" flange packing, about 700 tons are sold per year. The basis for this packing is rubber which is compounded with other substances in such a way as to give the heat resisting qualities that recommend the packing so highly. The joints are completed and made tight without baking. The process is not unlike the preparation of sheet rubber except as to the mixing of the compounds, which is a secret known only to Mr. Dale and to Mr. Deming, the Superintendent. Hydraulic presses to the number of 24 are employed about the small work. These have three plates each and are fitted with steam connections for vulcanizing. There is much more that is interesting in mill No. 1, including the manufacture of tubular and square packing, rubber matting and diaphrams.

Mill No. 2 is the oldest building and is a reserve plant of six mills or grinders, two sets of calenders and the necessary washing facilities. It is run by an independent steam plant and may be used when necessary.

In mentioning the product of the establishment the diaphragms for vestibuled cars should be included as an important branch of the work. These are made by hand and evidently with the greatest care and skill, the starting point in the process being, as before, sheet rubber and duck. It is understood that all of the diaphragms, or bellows connections, for the Wagner and the Pullman sleeping cars are made here under patents held by the Peerless Company.

An air of contentment is very apparent among the men in the shops. They are working by the day, and not on piecework. A mutual aid association has been formed among them, with insurance benefits. The shops are well ventilated and admirably lighted by windows and by electricity. Special protection against fire is obtained by automatic sprinkler systems fed by an elevated tank, as well as an equipment of 10 hose houses with a total of 1,500 feet of fire hose. A pump is reserved for fire purposes only, and the men are organized for fire duty.

The plant is an interesting development from a small beginning. When Mr. Dale became connected with the concern in 1888, mill No. 1 was the whole plant and only 13 men were employed. Mr. Dale knew the railroad requirements of rubber goods and became interested in the business through a burst air-brake hose on the West Shore road, where he held the position of trainmaster. He became convinced that there would be a ready market for the best air-brake hose that could be made, and he has been engaged in trying to carry out this idea. The use of the hose by the Westinghouse Air Brake Company, the Pennsylvania, New York Central, Chicago, Milwaukee & St. Paul, and nearly all of the large roads, speaks for the success of the attempt. The hose for all purposes is tested at regular intervals and so severely as to insure the exposure of any weaknesses or defects. An English contemporary in commenting upon the quality of rubber goods says:

"We doubt the policy of buying cheap and nasty mechanical rubber."

We doubt it also.

The officers of the company are as follows; Mr. C. H. Dale, President; Mr. C. C. Miller, Treasurer; Mr. Brown Caldwell, Secretary; Mr. John H. Deming, Superintendent, and Mr. W. J. Courtney, Manager Railroad Department. We desire to acknowledge the courtesy of Mr. Dale and also of Mr. Deming for the opportunity to inspect the works and for the information obtained.

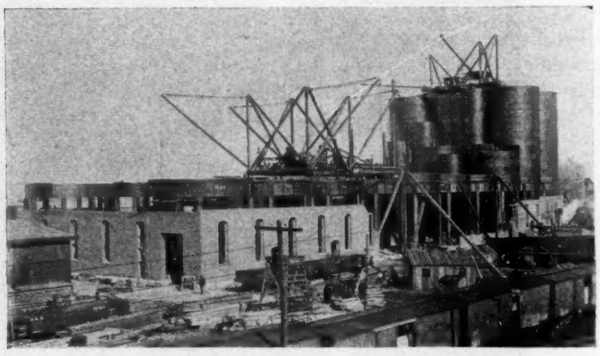
A New Method of Building Grain Elevators.

The engraving shown herewith was made from a photograph of the new grain elevator now building at Buffalo, N. Y., for the Great Northern Railway, under patents of Mr. D. A. Robinson. The method of construction is a radical departure from current practice in that the bins are cylindrical and of steel. There will be thirty bins in all, each having a capacity of about 100,000 bushels, giving a total capacity of 3,000,000 bushels to the complete elevator. The weight of the grain in these cylinders, which are 38 feet in diameter by 84 feet in height, necessitates extending the foundations to a depth of about 60 feet. The engraving shows small bins of 15 feet diameter between the larger ones. These are for the reception of the grain before it is placed in the large ones for storage. The whole system of bins rests upon steel work, which is placed above the foundation, and in the background of the engraving the bins have been carried to their full height. When completed the bins will be roofed over, giving the usual exterior appearance of an elevator. It is understood that the power employed in handling the grain will be taken from the Niagara Falls electric power plant.

Cost of Oil Fuel for Steam Boilers.

The trouble occasioned by the recent strike of coal miners has caused many steam users to investigate the question of the relative cost of oil and coal as a boiler fuel. Some interesting figures from Mr. Charles F. Foster, who was Mechanical Engineer of the World's Columbian Exposition, are printed in the *Engineering Record*, and we reprint the following valuable comparison and formula from that journal:

In determining equivalent costs of coal and oil for various prices paid for coal based upon the World's Fair results, we can establish



Great Northern Railway Elevator. Buffalo, N. Y.

a formula in which the price of the oil per gallon (A) multiplied by the number of gallons burned per horse-power hour (B) plus the cost of handling (C) is equal to the price of the coal per pound (D) multiplied by the number of pounds burned per horse-power hour (E) plus the cost of the handling (F), or

$$AB + C = DE + F$$

In this case $B = .3007$, $C = \$.00006$, $E = 4$ and $F = \$.00131$

$$\therefore D = \frac{.3007\,A - .00071}{4} = \text{\$ per lb.}$$

Multiplying by 2,240 to obtain the cost in dollars per long ton (T and symplifying, we have

$$T = 168.30\,A - .397.$$

Giving A various values from 1.5 cents to 3.5 cents, obtaining the value of T, we have the following table as showing the equivalent cost of coal per ton for oil at various prices per gallon, the evaporation and cost of handling each being taken the same as the World's Fair results.

Price of oil. Dollars per U. S. gallon.		Equivalent cost of coal in dollars per ton 2,240 pounds assuming the evaporation of coal to be $\frac{7.5}{14.25}$ of that of oil.	
.015	.0275	2.12	4.23
.0175	.300	2.55	4.65
.0200	.0325	2.97	5.07
.0225	.0350	3.39	5.49
.0250		3.81	

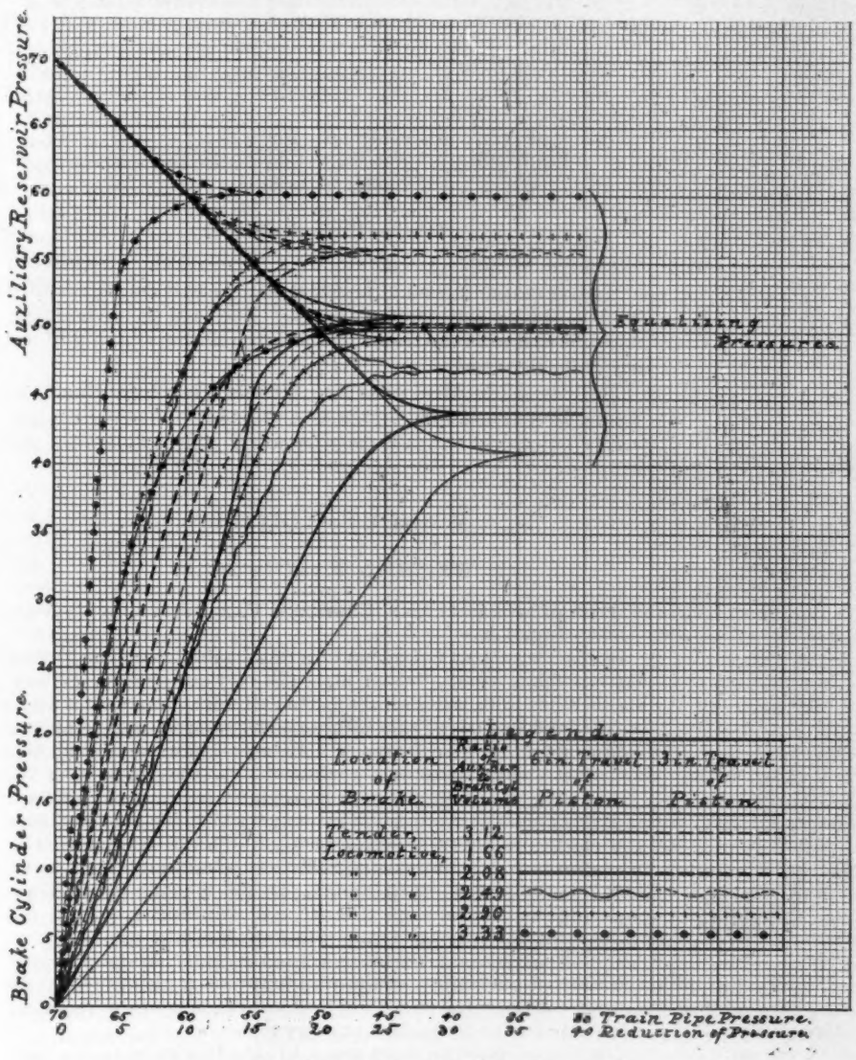
From the above it would seem that oil can seldom compete with coal when the question of price is concerned.

As far as the handling of the two are concerned, Mr. Foster found the cost of handling oil to be less than one-half the cost of handling coal. Were his figures applied to a smaller plant of, say, 500 horse-power in boilers, which would be capable of supplying a 1,000 horse-power compound engine and the plant run for 300 10-hour days, the cost of handling oil would be $900 and coal $1,965.

Experiments Upon Auxiliary Reservoirs.

BY G. R. HENDERSON.

The accompanying diagram gives a graphical representation of the effects of varying the capacity of the auxiliary reservoir for a given size of brake cylinder. The curves represent a travel of 3 and of 6 inches. Incidentally the effects of different reductions of train-pipe pressure are also illustrated. The experiments from which these curves were obtained were made for the purpose of determining practically the proper size of an auxiliary reservoir for operating the driver brakes of a locomotive. The engine had been fitted with two 12 by 10-inch brake cylinders and one 12 by 33-inch auxiliary reservoir, while the tender had an 8 by 12-inch cylinder and a 10 by 24-inch auxiliary reservoir. All were used as previously recommended by the Westinghouse Air Brake Company.



Experiments Upon Auxiliary Reservoirs.

It had been observed in service that the driver brakes did not hold properly when set with the regulation travel, and when the great disparity in volume between the engine and tender reservoirs relatively to their brake cylinders was considered, the reason at once became apparent. The volume of the tender reservoir was 3.12 times the volume of its single brake cylinder, while the volume of the engine reservoir was but 1.66 times the volume of its two brake cylinders. By comparing the fine and thick lines on the diagram it will be seen that while the tender brake equalized with 6-inch travel, at a pressure of 51 pounds, and with a reduction in train-pipe pressure of about 20 pounds, the driver brakes equalized at 41 pounds, and this necessitated a reduction in train-pipe pressure of over 30 pounds. For 3-inch travel, as shown by the dotted fine and thick lines, a similar discrepancy is found, and it will be noticed that 3-inch travel of the driver brake pistons gave approximately the same results as 6-inch travel of the tender brake piston. But a travel of 3 inches was too small to allow the brakeshoes to clear the wheels properly when the engine rolled in going around curves, which made it difficult to maintain the brakes.

Of course the proper ratio of volumes for the engine could be determined by calculation, but it was desired to make an actual test of the effect of varying the volume of the auxiliary reservoir on the locomotive. By coupling together different sizes and numbers of reservoirs, we obtained tests in which the auxiliary reservoir volume was 1.66, 2.08, 2.49, 2.90 and 3.33 times the volume of the two driver brake cylinders. The diagram gives a table designating the curves for each ratio, and it should be noted that the solid lines indicate 6-inch travel and the broken lines 3-inch travel of the brake pistons. The 2.90 ratio gave the closest approximation for the engine and tender at 3 and 6 inch travel, and as this was about equivalent to a 16 by 33 inch reservoir, this size was adopted.

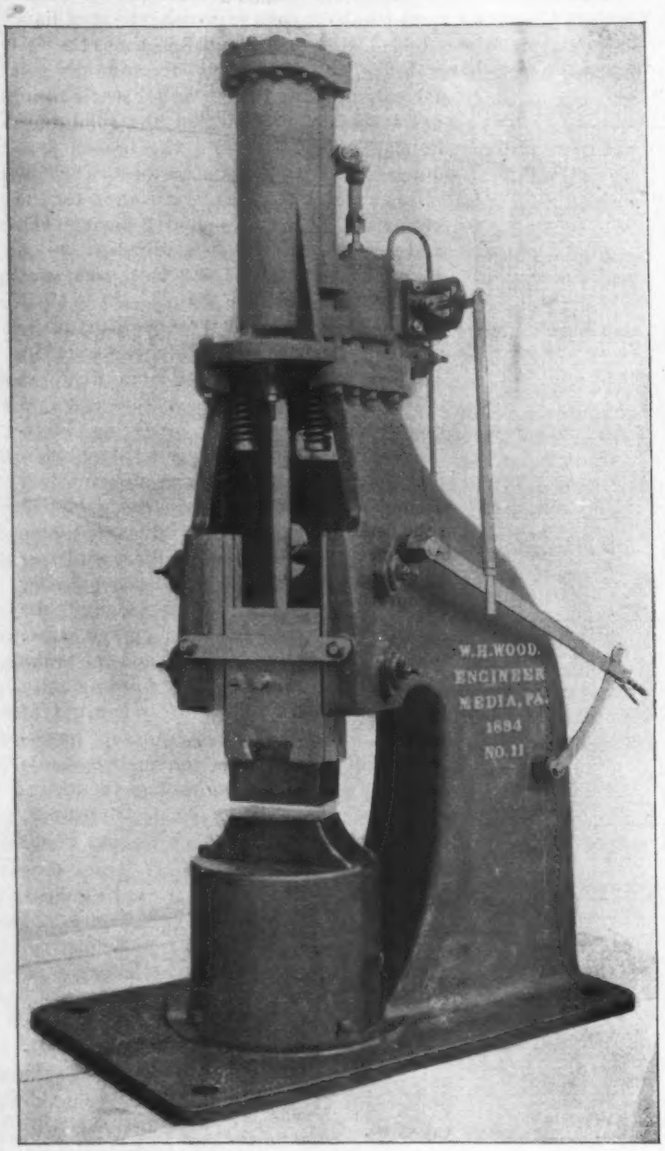
The effect of incorrectly proportioning the volume ratios may be readily seen from the diagram. The lines starting from the upper left-hand side of the chart show the auxiliary reservoir pressures, and those starting from the origin or lower left-hand corner show the brake cylinder pressures for various train-pipe pressures, measured along the axis of abscissas. As the train-pipe pressure is reduced, the auxiliary reservoir pressure falls in unison, the brake cylinder pressure rising, until the latter and the auxiliary reservoir pressure curves meet, when equalization is effected and the brake cylinder and auxiliary reservoir maintain one and the same pressure regardless of further reductions of the train-pipe pressure. This shows at a glance why it is useless and wasteful to reduce the train-pipe pressure more than 20 or 25 pounds, except when making an emergency application.

If, now, we consider the effect of the first-mentioned proportions of reservoirs and cylinders, it will be seen that while the heavy line shows 50 pounds cylinder pressure for 20 pounds reduction, or 50 pounds train-pipe pressure, the fine line shows but 26 pounds, and even if the train-pipe pressure be reduced to 30 pounds, we could obtain only 41 pounds in the driver brake cylinder. Of course the braking power will be proportionate to the brake cylinder pressures, provided the brake leverages are properly designed. A reduction of ten pounds in the train pipe would give 25 and 12 as the corresponding cylinder pressures. From the diagram we can therefore obtain the effects of various train-pipe reductions.

The importance of keeping the travel uniform is nicely illustrated by the chart. Let us imagine two tenders (or cars) in the same train; one has 3-inch travel and the other 6-inch travel. If now a reduction of 10 pounds is made, the brake with 6-inch travel will receive 25 pounds and the one with 3-inch travel 35 pounds pressure. (Follow up the 10 pounds reduction line to its intersection with the solid and broken heavy lines in the diagram.) A 20 pounds reduction causes equalization at 51 and 56 pounds respectively. A greater variation in travel would of course result in still greater discrepancies.

Wood's Single Standard Steam Hammer.

In the design of steam hammers the guides have constituted a special feature to which considerable attention has been given, and the form shown in the accompanying engravings has been arranged with a view of securing perfect alignment of the hammer head and to prevent the failure of piston rods through fatigue, which causes the breaking of many of these parts when put into the severe service expected of this class of machinery. The feature of this design is the patented guides, the construction of which will be understood by an examination of the photographic and sectional views. The section is taken through the frame, guides and hammer head.

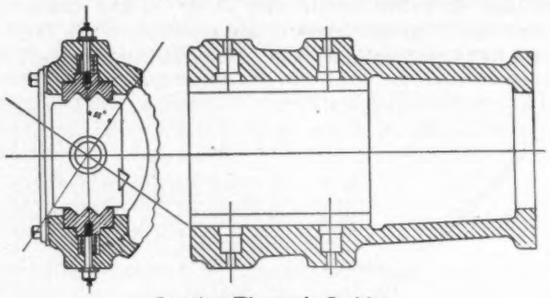


Wood's Steam Hammer.

In the standard in which the guides are formed and within which the hammer head works are vertical grooves with outwardly extending central apertured hubs on opposite sides. The guides for fitting in the vertical grooves have hubs on the back corresponding with the apertured recesses in the frame. On the back of each hub is placed a coiled spring which encircles the bolt which passes through the frame to the outside for adjusting the tension by the nut and lock nut on the guide against the hammer head, there being a small amount of clearance behind the guide and the main frame, which allows the vibration to be released at every blow, besides allowing the hammer head to adjust itself to any little irregularity that may occur while doing its work.

It will be readily understood from the photograph that the main frame of the hammer is of the ordinary type and that the cylinder and valve box are cast in one piece. The valve for working the hammer is of the annular type, which admits steam to the cylinder around the external circumference and exhausts through the center of the valve. It is fitted with a removable valve seat, so that it can be readily renewed. The valve is suspended on a lever attached to the rocker and connected directly to the shaft on which the handle with the trigger movement for working the hammer by hand or otherwise is attached.

The valve motion is very simple and the valve stem requires no packing. The piston is forged on the rod and is made of steel. The hammer head is of forged steel and the dies are of cast steel.



Section Through Guides.

The anvil is entirely separate from the hammer and is fitted in two parts so that in case of accident the top part can be renewed without taking the hammer apart. The base of the hammer, which is cast with the frame, is strongly reinforced and is ribbed below the floor line.

The patentee and builder is Mr. William H. Wood, Engineer, Media, Delaware County, Pa. He states that he had the requirements of railroad repair shops in mind when designing this hammer.

Communications.

Why Rails Break in Track.

EDITOR OF THE AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

In your September issue I notice a remarkable article on "Why Rails Break in Track," which, although very excellent in its way, seems to me to be going somewhat to extremes. Carry it a stage further and one might expect to see a rail twist up and break into fragments if it were looked at. In actual practice no such hair splitting is indulged in, as it would involve a large number of rejected rails, loss to the manufacturer, higher prices per ton, delays in filling orders, and other disadvantages which more than balance the slight danger of breaking in track. The method pursued by many roads is quite satisfactory, the rails being bought on a guarantee and replaced, when broken, by the manufacturer. What more can the railroad ask? The rail mill will furnish a good rail or be put to the expense of annoying replacements, and will furnish it cheaply, as it is then allowed to select the most economical method of manufacture, and is not treated as if the superintendent did not know the A B C's of his business, and was a rascal to boot, who had to be watched at every turn.

I will grant that the work done by Mr. Dudley is in the right direction, but how many roads in the United States are paying for such work and will the difference realized justify the expense? The next-door neighbor to the New York Central is the New Haven road, and if there is any difference in the roadbed and maintenance, I believe it is in favor of the latter, although it still follows the old-fashioned methods. The proof of the pudding is in the eating, and although such nonsense as is to be found in the article referred to often finds its way into print, let us be thankful it gets no further. COMMON SENSE.

NEW YORK, September 10, 1897.

[Our correspondent is frank if severe. We recommend him to come out occasionally and see what is going on around him. Makers' guarantees will not prevent or pay for wrecks, but many accidents may be avoided by compelling care in manufacture, by making good specifications and by careful inspection. These may raise the price slightly, but a poor rail is dear at any price.

The almighty dollar cuts too large a figure in a great many departments of railroading.—EDITOR.]

Locomotive Counterbalancing.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I have your letter of September 8th. I regret to say that I have not time to write a full reply to Mr. Henderson's communication printed in your September issue.

One of the greatest defects of our American railroad system is that different departments do not work enough together. The mechanical department tries to make the machinery which will give the most economical results, no matter what the effect on the track and structures. The track department tries to get the track which can be most economically maintained, without reference to its effect on train service. Nor is this confined to these two departments; every department works too much on its own account.

It is a common thing for master mechanics to say that they have no evidence that the varying weight on locomotive driving wheels does any harm. The presumption always is that a varying weight does more harm than a uniform weight. It is a well-established fact that there are certain limits of strain to which material can be safely subjected—that any strains in excess of these causes rapid deterioration. If one locomotive has a uniform pressure at all times of say 16,000 pounds on a driving wheel and in another this varies from 8,000 to 24,000 pounds, the simple fact remains that the rails which carry the latter must be able to resist one-half greater strains than those which carry the former. If it is more economical and satisfactory to use the heavy rails, thereby throwing the expense on the track department, well and good, but until this additional cost of track is taken into consideration no fair comparison can be made.

It is possible to make a perfectly counterbalanced locomotive. The fact that this can be done is a reason why it should be done. There is no method of making a perfectly counterbalanced locomotive except by counterbalancing the revolving parts by revolving parts and the reciprocating parts by reciprocating parts. This may be done by the use of four cylinders, all taking steam at the same pressure, as in the old Shaw locomotive, or the four cylinders may be utilized to take advantage of the compounding system, as in the Strong locomotive, or it can be done by a reciprocating weight. The most economical results, so far as fuel and steam consumption are concerned, will undoubtedly be obtained by the compound locomotive. The other machines will be simpler; possibly, for many purposes, they are to be selected, though the details must be far different from those of the Shaw locomotive or any design which I have yet seen using a reciprocating weight.

I thank you for your advance proofs of what you have written on the boiler performance, and also on the weights on the driving wheels. You are certainly correct in stating that "common practice in counterbalancing is a compromising makeshift not to be proud of."

GEO. S. MORISON.

NEW YORK, Sept. 15, 1897.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I have read with some surprise and a great deal of interest the letter of Mr. G. R. Henderson in your September issue, and can only account for the writing of such a letter on the ground of lack of information on the part of its author. It reminds me very much of a little incident that occurred some years ago on a certain Western road, which is interesting in this connection, where another man was equally confident with Mr. Henderson that his locomotive, or one under his charge, was the "best balanced locomotive on the road." A report had been sent into the office of the Superintendent of Motive Power that a lot of track had been spoiled on a division at some distance from headquarters, and two experts were sent out to make an investigation. They measured the distance between the bends on the rails and found they corresponded to the circumference of the driving wheels of a certain locomotive that was suspected of having done the damage. They then went to the Division Master Mechanic and told him that No. — had bent the rails, and that her counterweights would have to be looked after. The Master Mechanic replied that "that could not be, as she was the best balanced locomotive on the road and he could prove it." The experts asked how he proposed to prove it? "By taking her out and giving them a ride at 70 miles per hour, right away." They protested that this could not be done with their consent; but if he wished to do it at his own risk it would be all right. He said he would take all the risk, and ordered the engine out. They all got on, and went out about 10 miles to the top of a grade and started back, and came in at a very high rate of speed, no one on the engine noticing anything peculiar, but all agreeing that she rode very well, and when they had gotten back to the roundhouse and the engine was back in her stall, "Now, did I not tell you she was the best balanced engine on the road?" remarked the Master Mechanic, and they agreed with him and they went into the office and sat down to discuss it; but they had not been there very long before the foreman of that particular section entered the office with the remark, "Well, now, you fellows have just raised h—— with another five miles of track; the rails are so badly bent that they will all have to be taken up and new ones put down."

Now, that Master Mechanic had learned a lesson which should be useful to all railroad men, and especially to motive power men, that a good riding engine is not necessarily an easy engine on tracks and bridges. He was more excusable for his confidence in his belief that that particular engine was all right than Mr. Henderson is for the position that he takes, for he did not pretend to be an authority on counterbalancing, while Mr. Henderson does, as he informs us that he has read a paper before some engineering society, and then he goes on to show by his own figures that he is not acquainted with the first principles of counterbalancing, when he states that the remedy I propose "is like an antidote for a poison, instead of eliminating the poison altogether," and in the next sentence agrees that my arrangement of parts does perfectly what they are intended to do, and that the engine is perfectly balanced in every way. He complains that I have not eliminated the inertia of the parts that are made to balance one another.

Let us see what happens in this locomotive, and compare it with what happens on a locomotive such as he proposes. In the balanced locomotive that he refers to there are two pistons with their piston-rods, crossheads and one-half of their mainrods, of equal weight and as light as they can be made, always moving in opposite directions and coupled to the same axle at 180 degrees, and the pistons in the same saddle-casting and working on the same axle-box, about equally distant from the center of this axle-box, and having the revolving parts of the respective connecting rods and cranks balanced on the axle on the inside, and in the wheel on the outside at the same distance from the center of the axle, as the distance at which they revolve.

It makes no difference whether you suspend this axle on centers and allow it to stand in any position you wish to put it without any tendency for it to change position, or run it at 1,000 revolutions a minute, it is always balanced and there is no disposition to move up or down, or backward and forward; nor is there any pressure nor pound imparted to the axle-box or frame, nor to the track or roller, if it be mounted on rollers. The inertia of one part is absorbed and counteracts the inertia of the other part, within the cylinders by compression, and within the axle by pressure on the pins, but the disturbance does not go beyond the axle in any case, and, as the parts are made light by reason of the work being distributed over four cylinders, instead of two, the inertia that has to be stopped on the cranks is much reduced, and as there is no excess balance for reciprocating weight there is no disturbance of the center of revolution of the driving wheel.

Now let us compare this with the other method, of which Mr. Henderson claims to be the originator, but which is the same that has been in use since the days of Stephenson, and which all must acknowledge is a compromise, and no one can defend as being mechanically or mathematically correct, and which, while it has answered as a makeshift for slow speeds, becomes more troublesome as weights of locomotives increase and the public demands higher speeds.

He has designed a locomotive in which the reciprocating parts weigh, according to his figures, 696 pounds; he does not give us the weight of the engine, but he says that he proposes to allow $\frac{3}{10}$ part of its weight to remain as unbalanced reciprocating weight on each side of the engine. As he has not given the weight we cannot estimate just how much this is, but we assume that he has not departed from the rule of the Master Mechanics' Association, and that is to balance two-thirds of the reciprocating weight, which would be 464 pounds, and he states that this engine has 68-inch drivers, and that at 68 miles per hour it will not exceed 4,000 as the pressure in a vertical direction, due to excess balance at this speed.

Let us compare this statement with what occurs with a less amount of excess balance at a slower speed, as described by Professor Goss, in his report on the test of the balanced compound, as compared with another locomotive:

"To make the statement of the whole matter a trifle more technical, but vastly more comprehensive, it may be said that since the counterweights move in circular paths it is only the horizontal component of the radial force derived from them which can serve to neutralize the effect of the reciprocating parts; the *vertical* component of all that portion of the force which applies to reciprocating parts—that is, of the excess balance—is unbalanced. This unbalanced vertical component causes the pressure of the driver on the rail to vary with every revolution. If the counterweight revolves at uniform speed the radial force will be constant, but the value of the components will constantly vary, one increasing as the other diminishes.

"Whenever the speed of rotation is high, the unbalanced vertical component is, under conditions common in locomotive practice, of considerable magnitude, and its change in direction is so rapid that the resulting effect upon the rail is not inappropriately called a 'hammer blow.'

"A specific example will serve to illustrate this more fully. Assuming drivers of 63 inches in diameter running 60 miles an hour, every pound weight in the counterbalance will exert a centrifugal force of about 36 pounds. If the excess balance in any wheel for such an engine is equal to 400 pounds, the unbalanced vertical component reaches a maximum of more than 14,000 pounds, and it changes its direction from vertically upward to vertically downward at intervals of a tenth of a second. Again, if the conditions already assumed apply to an engine which has a load on each driver, when the engine is at rest, of 14 000 pounds, then, when running 60 miles an hour, the vertical component of the excess balance will just equal the static load upon the wheel; so that, at the instant the counterbalance is up, the wheel will entirely cease to press upon the rail, and when the counterbalance is down the wheel-pressure will be increased to 28,000 pounds; the change of pressure from nothing to 28,000 occurring, as already stated, in an interval of less than a tenth of a second.

"These statements, based upon assumed conditions, are sustained by theoretical consideration, and are fully confirmed by actual tests made upon an eight-wheeled engine in the laboratory of Purdue University, which demonstrated the fact that the driver of an engine in which the condition of balance was not unusual, could be made to leave the track at every revolution."

If we assume that the excess balance in Mr. Henderson's locomotive is placed in the main driving wheel, to avoid the transmission of the disturbance through the side rod brasses and other connections, or in other words, to keep it as nearly to the source of its origin as the balancing of the reciprocating parts are balanced in the compound, we will have 464 pounds of excess balance traveling at a higher velocity than the 400 pounds of excess balance mentioned in Professor Goss' example, as a 68-inch wheel at 68 miles an hour is moving at a higher velocity, and its counterweights are moving at a higher velocity than the counterweights in the 63-inch wheel at 60 miles per hour. Then, if Professor Goss be right, we have 464 pounds multiplied by 36, or 16,704, as the disturbance in a vertical direction. If we assume that this weight is equally divided between two driving wheels, we will have one-half of 464, or 232, and at every revolution the brasses in the side rod, in addition to doing the regular work, will have to stop and start in another direction 232 pounds every one-tenth of a second; and in addition to this there remains on each side of the locomotive 232 pounds of unbalanced weight, which has to be stopped and started in the other direction on each one-tenth of a second, which force comes on the axle-box on to the frame, and from the frame is transmitted to every part of the locomotive and train, and can be felt at the fifth and sixth car from the locomotive.

Now, which is the correct method—that embodied in the balanced compound or that proposed by Mr. Henderson? I will leave the reader to be the judge. GEO. S. STRONG.

NEW YORK, Sept. 7, 1897.

[In order to consolidate the discussion of the counterbalancing matter the proof of Mr. Strong's communication was sent to Mr. Henderson, and his reply is given below.—EDITOR.]

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

I am under obligations to you for showing me in advance a proof of Mr. Strong's letter attacking my remarks about the Strong Compound Locomotive. I cannot claim to be entirely free from ignorance on some engineering matters, especially when it comes to advocating crank axles for locomotives as a desirable mechanism; I am perfectly ignorant of the advantages of such construction. However, the particular line of ignorance which Mr. Strong thinks of in his article is not clearly set forth in his letter, and I have not been able to discover wherein my ignorance in this particular point has been illustrated. I did not merely state that the engine seemed to ride easily and comfortably, but further on gave the value of the blow of the counterbalance as 4,000 pounds, which we believe will be admitted is not a severe impact to place on the ordinary rails which are used at the present date, and I will show further on that these figures are approximately correct.

When the Master Mechanics' Committee reporting at the convention of 1896 practically adopted my rules and suggestions in regard to counterbalancing locomotives (see pages 150 and 154, *Proceedings* of 1896), I felt as if I did not know a little on this subject, or at least that the committee thought I did, and I would be very glad to know how Mr. Strong was sharp enough to discover that I was not even acquainted with the first principles of the subject.

I certainly have no desire to detract from any of the glory due Mr. Stephenson or his work in the early days of the locomotive engine, but I have yet failed to discover that Mr. Stephenson recommended that the unbalanced reciprocating parts might be a definite proportion of the total weight of the engine.

The reason why I did not give the detailed weights in my previous article was that the reader should not be burdened with a needless array of figures, but as there may have been some misunderstanding caused by the omission, I will give them for the benefit of those interested. The engine in question has a gross weight of about 135,500 pounds, and $\frac{1}{344}$ part of this weight would be about 398 pounds. Mr. Strong assumes that we balanced two-thirds of these reciprocating weights and refers to an obsolete rule of the Master Mechanics' Association. The latest authority on this subject is probably given in the Master Mechanics' report of 1896, on page 151, in which no allusion is made to any fractional part of the reciprocating weights, but states that the unbalanced weights should be a function of the whole weight of the engine.

As the total amount of the reciprocating weight is, as stated previously, 696 pounds, the 398 pounds above mentioned substracted from this would leave 298 pounds of reciprocating weight to be balanced. If Mr. Strong will refer to the 151st page above mentioned, he will also see that this weight should be divided equally among all the driving wheels instead of placing it all in the main wheel, as he assumes that I have done. By following the rule given, this 298 pounds should be divided among three wheels (the engine being of the ten wheel type), which would, therefore, give 99 pounds to be placed in each wheel. As a matter of fact, however, the distribution did not come out exactly equal, but gave us as follows:

1st wheel.....117 pounds.
2d " ..... 90 "
3d " ..... 91 " of excess balance.

Thus it will be seen that the excess balance in any one wheel was not near the 464 pounds which Mr. Strong assumes that we had, but had a maximum value in first wheel of 117 pounds, and as this wheel had actually the lightest load due to the weight of the engine, it prevented an excessive total loading on any of the wheels. In order to obtain the effect of this excess balance at 68 miles per hour, we actually multiplied the above figures by 40 (see page 154, *M. M. Proceedings* 1896), which is greater than Professor Goss' value, which he placed at 36 pounds per pound excess balance when a 63-inch wheel was running at 60 miles per hour. The actual value would be really 38.4, but we take 40 pounds for the sake of even figures. This, it will be found, gives us a load due to the counter-balance, as follows:

1st wheel.....4,680 pounds
2d " .....3,600 "
3d " .....3,640 " at 68 miles per hour,

the wheels being 68 inches in diameter. The total maximum possible load then, including the static weight of the engine and the centrifugal effect of counterbalance, gives us from 18,000 to 23,000 pounds per wheel, which we hardly think would be excessive with the present strength of track.

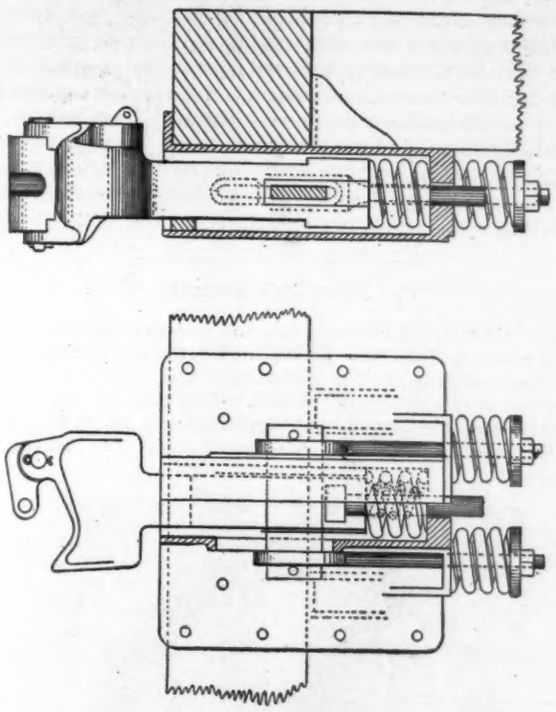
While of course we know and have stated that the four-cylinder method will give an approximate balance to reciprocating and revolving weights, both theoretically and practically, yet we cannot help feeling that the approximate method above outlined with two cylinders and their connected parts would be preferable under the majority of conditions both for construction and maintenance of equipment. G. R. HENDERSON.

ROANOKE, Va., September 16, 1897.

A most remarkable record for fast time and punctuality has been made by the Philadelphia & Reading Atlantic City Flyer during the past summer. From July 2 to Aug. 31 the average running time for 55.5 miles was supposed to be 52 minutes, or an average speed of 64 miles an hour. Owing to ferry delays the actual time for 52 days was 48 minutes, or 69 miles an hour, and not once did the train arrive at Atlantic City late. On 22 days the train had five cars and on 30 days it had six cars. The performance called forth a complimentary letter from Vice-President Voorhees to the engine runner, and it was deserved, as the record is unique.

The Acme Tender Drawbar Pocket.

The locomotive tender drawbar pocket shown in the accompanying engravings was designed by Mr. R. M. Galbraith, General Master Mechanic of the St. Louis Southwestern Railway, and is controlled by the Western Railway Equipment Company of St. Louis. Mr. Galbraith has tested the device thoroughly, and says that its chief advantages are that a tender may be equipped with the ordinary M. C. B. freight-car coupler, which only requires 20 minutes' work for attachment after the tender has been equipped with the pocket. He says: "We find that it has the effect of relieving the engine from excessive jar when slack runs up, and it practically relieves the tender draft rods from



Acme Drawbar Pocket.

shock. We find that with its use repairs to the draft gear of our tenders have been very largely reduced."

The pocket casting is of malleable iron, with the proper provision for receiving the coupler shank and buffing spring. A key passes through a transverse slot in the coupler shank in a way similar to that of the continuous drawbar attachment. The looped ends of two side stems are passed over the ends of the key and held in position by cotters. These stems carry followers on their ends which bear against springs seated on the outside of the pocket casting for the purpose of transmitting pulling stresses. The pocket castings may be designed to fit any tender frame. The manufacturers believe that by the use of this device the pulling out of the tender draft rigging, except in bad wrecks, will be entirely avoided.

Rolled Steel Axles.

The Keystone Axle Company, of Pittsburgh, has recently made a successful test of its rolled steel axles at the plant, which is located at Morado, near Beaver Falls, Pa. The preparation of the plant has been in process for a long time and on Saturday, August 14, the first public test was made under the direction of the Pittsburgh Testing Laboratory. The roll in which the axles are made is 98 inches long by 48 inches in diameter. Dies shaped properly to give the axle its outline, and conforming to similar outline in the roll, form a backing against which the axle bears during the process. The space between the roll and the backing is wider at the point of entrance of the metal billet and gradually tapers down to the proper distance to give the rough finished dimensions to the axle.

The roll is turned by a direct connected 800 horse-power engine, built by the Philadelphia Engineering Company. The cylinder is 24 by 42 inches. Steam is furnished by 200 horse-power Brownell boilers. The furnace is so arranged as to heat continuously and has a capacity of 60 tons per day of 10 hours, the fuel being natural gas and coal. The plant is contained in a steel building 80 by 208 feet in size, which is conveniently located on the Pittsburgh, Ft. Wayne & Chicago Railway. The capacity of the present equipment is 600 axles per day of 24 hours. The following is the report of the test referred to:

Blows.	Deflections.
1	$5\frac{9}{16}$ inches
2	$6\frac{3}{32}$ "
3	$6\frac{5}{16}$ "
4	$6\frac{11}{32}$ "
5	$5\frac{13}{32}$ "

The distance between supports was 3 feet, the height of the drop 28 feet 6 inches, and the weight 1,640 pounds. The table of deflections gives those for the first five blows only, and other tests suggested by those present are said to have been satisfactorily met. The office of the company is in the *Times* Building, Pittsburgh. Mr. D. A. Clark is President and Mr. Thomas R. Torrence Secretary.

Tieplates.*

The result of observation and experience with the tie plate is, that when properly designed it is superior to the rail brace, in not only performing the function of the brace, but also in possessing additional merit of its own.

The function of the rail brace is to prevent the widening of the gauge by transmitting through the brace to the tie a part of the lateral thrust which otherwise would pass to the outer edge of the base of the rail, and also to prevent the outward turning of the rail in consequence of its cutting into the tie. The rail brace only partially accomplishes this. The rail brace does not prevent the rail from cutting into the tie, and when this is the condition much of the wheel pressure is transmitted through the head of the rail to the brace, making it a lever with the fulcrum near the base of the rail, and when in this position the spikes which secure it to the tie offer but little resistance to the track spreading or rail turning, a fact well known to every roadmaster. By using a properly designed tie plate the cutting of the tie may be prevented and the gauge maintained without the aid of the rail brace.

The extent to which the life of the tie may be prolonged by the use of the tie plate depends upon the traffic, the kind of tie timber, and a full knowledge of the existing or governing conditions. For example, on switch leads, where the track is in constant use, it would undoubtedly outlast several tie renewals; and on bridges, where the ties are more expensive, and where the labor renewing them is considerable, they are a wise economy. Also on main track under traffic where the ties are worn by abrasion due to the wave motion of the rail, the tie plate would undoubtedly prolong the life of hard-wood ties from one to three years, and soft wood from three to six years.

As smooth riding curves are desirable in practical track work as well as essential in general railroad operations, your committee believes that the use of the tieplate on hard-wood ties on curves of two degrees or more, and on all joint ties on tangents and curves of less than two degrees; also on soft-wood ties on tangents and light curves, a plate being on each tie, would result not only in a saving of labor and material, but in obtaining a higher standard of excellence, as next to rail, ties and ballast the tieplate is indispensable in securing good gauge, line and surface.

In addition to the saving, first, in rail, by reducing to a minimum the wear due to impacts and the uneven wear due to the rail getting out of position; and, second, in spikes, by fewer being cut by the vertical and lateral movement of the rail; and, third, in ties, by preventing the rail from cutting into them and by less spiking to rectify the gauge, thus prolonging their life and reducing the yearly renewals, which itself, your committee thinks, would warrant the favorable consideration of the plate, the advantage to be obtained by the use of the plate are better surface and gauge; the maintaining the rail in its normal position, enabling the motive power to be used more efficiently; the decreased wear and tear of rolling stock and the generally economical operation not only in the movement of freight, but also in safety to passengers. . . .

An essential feature of the tieplate is that it should have perfect

* From a committee report to the Roadmasters' Association of America 1897 convention.

mechanical union with the tie to prevent vertical and lateral movement, which would result in the working loose of the plate and widening of the gauge or spreading of the track. . . . In order to obtain the best results from the tieplate, it should be properly applied, the tie being well adzed to an even bearing for the plate, so as to decrease the tendency for it to buckle. It should be imbedded in the tie when applied and not left for the train to settle to position, thus exposing it to the liability of sand and gravel to get under to bend it. It should be so punched as to secure a snug fit to avoid any lateral movement of the rail, and the spikes should be driven vertically.

New Armstrong Pipe-Threading Machine.

The machine which we illustrate in the accompanying engraving is the outcome of frequent calls received by The Armstrong Manufacturing Company, for a machine threading from ¼ to 2-inch pipe, and the usual desire of that company to turn out a tool for this purpose superior in construction and operation to any heretofore manufactured.

It will be known as the Armstrong No. "0" pipe-threading machine and uses the well-known regular Armstrong adjustable dies which are put in the machine and adjusted in the same manner as in the hand stock. These dies can be opened after cutting a thread, and when the pipe is removed they may be locked back to the standard size without re-setting. This is

The New Armstrong Pipe Machine.

accomplished by an automatic locking device which is operated by simply pulling a knob. The dies, however, can be adjusted to the variations of the fittings, the same as in the stock.

All the gears and moving parts of the machine run in oil, being enclosed in a chamber which covers and protects them from chips and dust, doing away with any possible chance of chips and dirt getting into the gears. The machine is self-oiling in all its parts, oil being admitted through two holes which are closed by screw plugs. The die head has no teeth on the part where it fits into the shell and forms a bearing; in this way its bearing surface is preserved and it is impossible to work loose, a common occurrence with some makes of pipe-threading machines.

In addition to the die-carrying head forming a bearing in the manner shown, it has an inner journal, thereby increasing its wearing surface. A very powerful self-centering vise, which exerts its power from the center of the jaws and not on the side, is used with this machine and will hold the pipe, being threaded with a light pressure of the wheel.

The construction of the machine admits of its being attached to a post on the side of a building or to a bench. This is a very desirable and entirely new feature and one found in no other tool of its kind. Another, and one of the principal features of this machine, is its two speeds, a change from one to the other being effected by merely changing the crank from one spindle to the other. In one case the operator can cut from ¼ to 1-inch pipe, inclusive, with great rapidity, then, by changing the crank to the other speed, from 1¼ to 2 inches, inclusive, thus avoiding the necessity of turning a great number of times on small pipe.

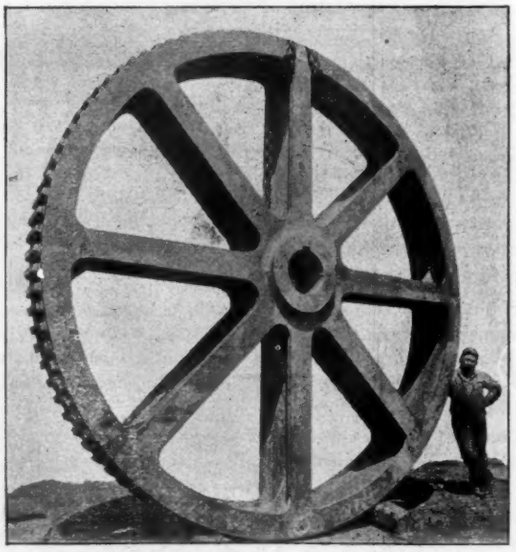
To operate this machine the vise is pushed back and the pipe is entered into the mouth of the dies, then by pressing the feed lever and turning the crank the pipe is fed into the dies. When the pipe is flush with the dies the small lever, shown on the under side of the die head in the engraving, is pressed toward the die which releases the locking device, and by pressing the knob on the opposite side the dies are thrown open. If the vise with the pipe is then pushed back and the knob pulled out, the dies are reset ready for threading another piece of pipe. The locking device adjusts itself automatically.

As this machine uses the regular adjustable dies, it can be furnished with dies for threading pipe from ⅛ to 2 inches, either right or left, or with bolt dies for threading from ¼ to 1¼-inch rod, inclusive, also with dies for threading brass tubing and conduit pipe.

This new Armstrong Pipe-Threading Machine was shown at the Gas Exposition recently held in Madison Square Garden, New York City, where it attracted a great deal of attention and caused much favorable comment. Any further information which our readers may desire will be gladly furnished by The Armstrong Manufacturing Company, either at their factory in Bridgeport, Conn., or at the New York office, 139 Centre street. The company is also making this machine to work by power as well as by hand for use in large shops and mills.

The New York Railroad Club.

The subject of lubrication of cars and locomotives was discussed at the meeting of the New York Railroad Club which was held on the evening of Sept. 16. The introduction was by Mr. Charles Miller, President of the Galena Oil Works, whose remarks were chiefly directed toward emphasizing the importance of using lubricants of the best quality for the purpose mentioned. The lubricant for



A Large Cast-Steel Gear Wheel.

axles was likened to the use of rollers under heavy weights for the purpose of moving them and it was evident that the quality of the material of the roller had much to do with the ease of handling the weight. Hard wood was better than soft for rollers under a block of stone, and iron was better than hard wood. The speaker showed that it was important to attend to the matter of lubrication for several reasons, the chief of which being that it was economical in the end to use good oils, the repairs of equipment were less and the number of cars hauled were greater when good oils were used on the journals. Many motive power men were trying to save oil. He urged them to present the subject to the enginemen in the form of the desired increased mileage returns and would advise giving the men all the oil needed or asked for.

Mr. Mendenhall thought that the greatest saving in connection with lubrication was to be had by looking after the wasting of oil. It was not so important to save some of the oil actually used, but was very important to stop the wasting of oil.

Mr. Higgins believed that hot boxes were the result of mechan-

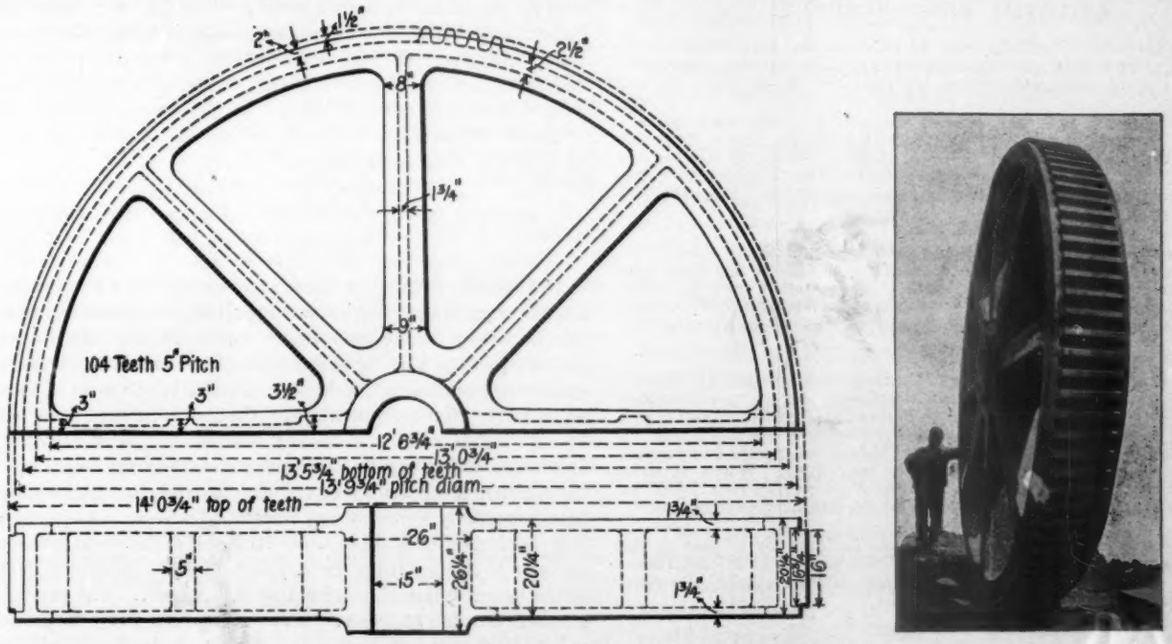
ical defects and the increased weights upon journals without proper provision for increasing the bearing surfaces. He had had good results from insisting that inspectors should let boxes alone when they were running satisfactorily, and he believed that there was no need of stirring up the packing unless a box ran hot. They were packed too often in ordinary practice. Mr. Forney raised the question of why oil lubricates bearing surfaces and was not satisfactorily answered.

After a brief discussion of the subject of copper spots on bearings and on improved oil records which had been secured by the use of good lubricants—which were always favorable to these lubricants—the meeting adjourned.

A Large Cast-Steel Gear Wheel—By the Sargent Company.

A drawing and photograph of a large gear wheel made in cast steel by the Sargent Company of Chicago have been received from that concern. It will be admitted that there are few more difficult castings to make than gear wheels, and when of such large size as this one, 13 feet 9¼ inches pitch diameter, the workmanship at the foundry and the furnace must be excellent in order to secure satisfactory results. The wheel weighs 28,175 pounds, and was made for the Great Western Tin Plate Company, of Joliet, Ill., the machine work being done by the Bates Iron Works of that city.

The diameter of the wheel is 14 feet ¼ inch over the teeth and 13 feet 5¼ inches at the bottom of the teeth. The width of face is 20½ inches, and the teeth are 16 inches wide, shrouded as shown in the engravings. Other details of the design are clearly indicated, among which is the diameter of the shaft, 15 inches, and the length of the hub fit 26½ inches. There are 104 teeth, the pitch being 5 inches. It is only a comparatively short time since cast steel would have been distrusted for such purposes as this, and the fact that a 14-ton wheel is made in this way shows that a complete change has been wrought in the confidence reposed in this material.



A Large Cast-Steel Gear Wheel by the Sargent Company.

The Railway Signaling Club.

The regular September meeting of the Railway Signaling Club was held at the Grand Union Hotel, New York, Sept. 14, with an attendance of about 30, the meeting being very successful.

The president in his opening remarks stated that the membership had increased to 71. He explained the action taken by the club with reference to the interlocking rules, and stated that those recommended by the club were under consideration by a committee of the American Railway Association. He urged action by the club along lines of recommendations for practice as being the most useful work that could be done, and in his remarks gave weight to the fact that the club was not a local one in any sense, though its meetings had heretofore been held in Chicago.

The report of a committee on primary batteries was read, giving the results of a series of tests on the Edison-Lalande, the Gordon and the ordinary gravity battery, the results showing the last mentioned to be far cheaper than the others, not only in first cost, but also in cost of operation per ampere hour.

The paper of the meeting, by Mr. Chas. Hansel, entitled "A Moral and Physical Agent in Safe Railway Travel," was then read and the meeting adjourned until evening.

In the evening the paper by Mr. Sperry, presented at the March meeting, was declared open for discussion simultaneously with that by Mr. Hansel, but though the session was long, only three general subjects were treated: colors for night signals, the advisability of using derails and the merits of electric locking. The result of the discussion on night signals was to refer the question to letter ballot for the members to make recommendations as to what ground the club should take on the question.

The derail matter was pretty thoroughly taken up and a tendency on the part of some of the members to question the advisability of using them was shown. Several members who formerly advocated the use of derails were now doubtful as to the net gain in safety, which had been thought to be attained by them. Positive opinions were not expressed, but it was shown to be advisable to secure reliable data as to the cases in which derails had saved accidents, the number to be compared with the number of accidents which had resulted directly from their use. Such figures were not now available, and it was necessary to have records in order to understand their real value. Considerable weight was given to English experience, in which, with an immense train mileage, very few accidents occurred. The perfection of discipline would render them entirely unnecessary.

Opinions differed with regard to electric locking. It was considered an absolute necessity, in order to render derailing switches safe, but members whose experience had been widest with it were convinced that the complicatons it brought into signal plants were a fatal obstacle. They were men who had used the earlier apparatus, however. The meeting adjourned until 7.30 Wednesday evening.

By courtesy of the Lehigh Valley Railroad and the National Switch & Signal Company, the club was invited to inspect the signaling of the road and the works of the Signal Company at Easton, Pa., on Wednesday, and was handsomely entertained by Mr. Hansel.

In the evening session the principal work done was to refer the question of the desirability of using derails to a special committee, Messrs. C. Hansel, W. H. Elliott and Henry Johnson. This committee was instructed to collect data with regard to accidents prevented and caused by derails, and was instructed to consider the question of electric locking and the proper distances between danger points and derails and between home and distant signals. Another committee, Messrs. H. M. Sperry, G. H. MacDonough and C. L. Addison, was appointed to report upon permissive block signals, the interlocking plants as suggested in Mr. Sperry's paper. Messrs. A. H. Rudd, W. W. Young and F. Rhea constitute a committee to report recommendations with regard to a number of mechanical details of interlocking mechanism.

On Thursday the club went from New York over the New York, New Haven & Hartford to Hartford for the purpose of inspecting the interlocking plant at that point and the third-rail system between Hartford and Berlin.

(Established 1832.)

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Probably most of our readers have read the published accounts of the collision on the Denver & Rio Grande Railroad, in which the wreck was reported to have been set on fire by the explosion of a Pintsch gas tank under one of the cars. It is difficult for us to believe that a gas tank could explode in a wreck, and how the gas tank could set fire to anything any more than could the water cooler is a mystery. There is likely to be a strong odor of gas about the wreck of a car carrying the Pintsch equipment, and if the wreck should be set on fire it is possible that the gas might escape and burn, but the claim that a gas tank exploded and set fire to the wreck will be commented upon very briefly. It is absurd, ridiculous.

The life of an unskilled laborer from the standpoint of one of them is portrayed in a series of articles by Walter A. Wyckoff in *Scribner's Magazine*, which everyone should read. Sociologists theorize about the condition of the lowest class of laborers and statisticians present their case in a light which enlists sympathy and excites concern, but the author of these articles records the life itself as he found it during two years of experience as a common laborer working in various gangs. He has a deep purpose, is intensely in earnest and the combination of his subject and his style is irresistible in its effect upon the reader, forcing the conclusion that half the discomfort and discouragement of these men is to the majority unknown.

The problems of providing adequate rapid transit facilities in large cities are worthy objects for the exercise of the best of engineering skill. Different conditions are found in each large city, and one by one the demand for better short and long distance urban transportation compels each to take up the question for itself. Boston is just congratulating herself over the opening of one of the principal portions of its subway, and is busy with the project of an elevated railroad. New York is discussing the underground plan, and has just agreed with Brooklyn to allow the trolley and elevated railroad trains of the latter city to cross the East River Bridge. All of these are important schemes, but the rapid transit question is one that will not stay solved. It will come up again in a new way very soon, and it begins to look as if the provision for this sort of transportation would become a most important branch of engineering. In this connection the rapid growth of large cities is significant. Josiah Strong has shown in *The North American Review* that while 175 years were occupied by New York in gaining the first 33,000 people, a gain of 280,000 was shown during the next 50 years. The next 30 years showed a gain of 630,000, and the following 21 years, ending in 1890, one of 859,000. The population in 1890 was larger than any one of 28 great states of the Union. In 1790 only three per cent. of our population was urban; in 1890 the ratio was 29 per cent. London's great growth has been comparatively recent, four-fifths of it having been made during the present century. All this goes to show the tendency for people to flock to the cities, and the causes are easy to find. This is no new discovery, but it is probable that few people realize the rapid growth of cities. That is not our object, however, but to show the importance of the transit problem.

WEIGHTS ON DRIVING WHEELS AS RELATED TO COUNTERBALANCING.

The great weight of the modern locomotive, whether for freight or passenger service, has for a long time caused uneasiness on the part of bridge and track engineers, and the limitations placed upon the driving wheel loads have seriously handicapped motive power men in producing locomotives to meet the increasing severity of requirements for fast and prompt train service. The allowable weight on driving wheels is nearly always fixed before the design can be laid out and usually the limiting factor throughout is the ability of the tracks and bridges to stand the load. Recently a design was completed and it was found necessary to reduce the weight of the locomotive by nearly three tons in order to come within the stipulated loads. Most of it came out of the boiler where it could not well be spared. The capacity of a locomotive for fast heavy service depends very largely upon the boiler and it is desirable to increase the boiler power to the highest degree for another reason, that of economical operation. A prominent superintendent of motive power has said that the track is at fault, that the locomotives must be heavy and that they must run fast. The track in his opinion should be made ready for locomotives far heavier than those now used, and he believes that the increased earnings secured by heavier engines would pay the bill. Perhaps he is right, but we would ask him whether he is getting the best use of the weights now existing.

The limit of locomotive improvement upon present lines has undoubtedly been nearly if not quite reached. We have driving wheel loads of 24,000 pounds per wheel and boilers have been built for ordinary service within the past year with as much as 2,900 square feet of heating surface. A heating surface of nearly 2,500 square feet for a passenger engine, while not common, excites comparatively little comment. The new 10-wheel passenger engines for the Northern Pacific have 2,485 square feet of heating surface and, as indicated in the details of the design given in our June issue of the current volume, the weights are about as large as can be taken care of with the limitation of about 18,500 pounds per driving wheel. The tendency to turn to the 10-wheel type of engine for this design is caused by the necessity for providing great boiler power for the engine. The question now arises as to what is to come to the relief of the designer who is compelled to meet the next advance in requirements. The ad-

vantages to be gained by hauling heavy trains are so great as to practically compel the increase of power in locomotives although many bridge and maintenance of way engineers are now afraid that the thing has been carried too far. It may be taken for granted that some way must be found to reduce the wear and tear of locomotives upon the track. This would admit of increased wheel loads and would provide at once for an expansion of the boiler to a degree that would not only insure plenty of steam but would make it possible to operate the engine more economically.

These paragraphs are prompted by the prominence that has recently been given to the subject of locomotive counterbalancing, brought about by the tests of the balanced compound locomotive by Professor Goss at Purdue University. It has been highly interesting to read the comments which have been printed concerning the counterbalancing of locomotives and one apparently very important part of the question has thus far been entirely ignored or overlooked. That is, the effect of a perfect balance upon the design of the locomotive.

It would be hardly fair to say that various writers in the technical press underrate the importance of counterbalancing or that they uphold present practice on its merits, yet it seems strange that it does not occur to them at once that a perfectly balanced engine might safely be allowed from 15 to 25 per cent. more weight upon its driving wheels than is at present allowable. It is not enough to suggest that reciprocating parts must be lightened and that larger driving wheels should be used. The reciprocating parts ought to be lightened for reasons entirely outside the question of counterbalance, and it will be impossible to cure the evil in this way. As to the use of large wheels it may be said that they cannot be applied to freight engines, and therefore the counterbalance difficulty is not to be solved in that way.

It is not enough that the driving wheels should be kept down on the rails but, as we look at it, the important matter is to reduce the pressure upon the rail caused by the excess balance. Speeds of 68 miles per hour are not at all unusual, yet the additional weight of 4,000 pounds may be applied by the action of the excess balance to the load upon each driving wheel of an engine that is now considered very well balanced when running no faster than that. This may be considered as a remarkably good result. An extreme case is quoted from the paper by D. L. Barnes, read before the International Engineering Congress in 1893. In discussing the subject of reciprocating parts he says:

"It is not just to say that all American engines have such very heavy reciprocating parts as has been indicated here, but as a rule American engines have these parts much heavier than is necessary, and this leads to the excessive counterweights which have given ground for a just criticism of this feature of American locomotive design. For instance, some compound locomotives have been built in this country with a single piston weighing over 800 pounds. The builders did not realize at the time the result of this, and put in as much counterbalance as was necessary to make the engine ride well. The result was almost disastrous to the track at 60 miles an hour, the maximum pressure on the rail reaching nearly 50,000 pounds per wheel."

This was of course an extreme case of an overbalanced engine, but the effect upon the tracks of engines balanced as well as they may be, after the prevailing plan, must necessarily affect the tracks to greatly increase maintenance expenses, even if the rails are not actually kinked. It is probably not generally understood that the tracks of many of the best roads costs from $700 to $1,000 per mile annually for repairs.

Mr. Strong's design does not appeal to us as likely to be at all well received owing to the great number of parts. There are, for example, 16 glands on the engine as against four for one of the ordinary two-cylinder type. He has accomplished most valuable results in showing that a locomotive may be counterbalanced perfectly and in bringing the whole counterbalance question up for discussion again. It is no new subject, but on account of its bearing upon other vital factors in locomotive and track work it is more important now than before the locomotive had reached its present stage of development.

The best suggestion that we can offer is that the whole counterbalance question should be discussed in its relations to other important things beside the smooth riding of engines, the lifting of wheels or the actual indentation of rails. The American Society of Civil Engineers, the American Society of Mechanical Engineers and the American Railway Master Mechanics' Association could bring out the meat of the question if joint effort should be made, and the result of a thorough investigation of the subject would show whether heavier rails are necessary and whether locomotive weights may be increased. Common practice in counterbalancing is a compromising makeshift not to be proud of. If it is the best practicable plan it will survive, but there would appear to be so much depending upon counterbalancing as to warrant going into the question more deeply than has been done. The real merits of counterbalancing should be determined, and if we are correct in our view of the case a satisfactorily counterbalanced engine will be forthcoming if it is needed.

In this connection attention is called to the translated description of Herr Von Borries four-cylinder compounds, which appears elsewhere in this issue, together with his arguments showing the advantages of that type of locomotive.

THE ENGINEERS OF THE NAVY.

There is a strong probability that the important line and staff question in the navy will be taken up vigorously by Secretary Long in his annual report to Congress. Both he and Assistant Secretary Roosevelt are giving considerable time and attention to the matter, and it is to be hoped that the engineers will receive the recognition which they not only deserve but absolutely require for the proper discharge of their duties. A very important suggestion has just been offered by Prof. Ira N. Hollis, which, it is believed, is likely to be received favorably. It has the merit of a sensible solution of the problem, and its effect would be to place the officers of the navy on a basis consistent with the progress which has been made in the ships themselves. They are no longer sailing vessels, but machines for engineers, not old-time seamen, to handle.

If the suggestion becomes a law, the engineers' organization, as at present existing, will be abolished, and all officers will be educated at the academy exactly alike. They will all be taught the engineering and navigating studies, and there will be no distinct study of sailing navigation and engineering in the courses. A strong emphasis will be placed upon engineering, and in fact all officers will be engineers. Professor Hollis says in effect: Let the officers in command of the ships become engineers, and let the engineers rule or shipboard.

The work now performed by the staff would be done by the lower grades of the line officers, and an extension of the length of the course in the Naval Academy is included in order to permit of giving all of the cadets the necessary instruction in engineering subjects. The first six years of service will be devoted equally to the line and engineering work, and after 12 years of service officers may choose between the corps of chief engineers and the line. The chief engineers will have full charge of the mechanical appliances on the ship, and will be responsible to no one below the captain. They will not be obliged to spend any time in the actual running of the machinery, as that work will all be performed by the line officers, but they will be free to attend to the engineering of the ship. On the other hand, a chief engineer will cut himself off from any opportunity for promotion to command. His work will consist in the installation and maintenance of the machinery. This will probably be a very popular branch of the service, and the chief engineer will be, next to the captain, the most important officer on board a ship. The executive officer will command the crew as a fighting unit, and the engineer will be an engineer in fact as in name. The line officers will also all be engineers, having had 12 years of close contact with the machinery, and it is reasonable to suppose that they will be the better able to command for the experience that they will have with the elements that they will have to control.

The plan provides room for all of the members of the present engineer corps in the new corps of chief engineers after they have been in service 12 years, and there seems to be no reason to anticipate anything but good results if the scheme passes Congress. It seems probable that all of the friction existing at pres-

ent would be removed, and as far as a careful consideration of the proposition can show, there are no drawbacks connected with it. We have given considerable space to earlier discussions of this important subject, and are now glad to be able to say that a satisfactory solution seems to be possible. We cannot see wherein the present line officers can object to that which will undoubtedly improve the service, and it is possible that they may give the plan hearty support. Almost the same suggestion was advanced in 1863 by Gideon Welles, then Secretary of the Navy. The time was not ripe for it then, but it is believed to be so now.

BOILER PERFORMANCE OF THE BALANCED COMPOUND LOCOMOTIVE.

Through the courtesy of Mr. Geo. S. Morison we have received a copy of the report by Professor Goss on the tests recently carried out at Purdue University on the balanced compound locomotive. The report is elaborate and is a characteristic example of the experimental work of Professor Goss in its clearness and thoroughness. The tests brought out a number of interesting facts concerning the boiler of the engine which are worthy of comment. The results of the engine test were disappointing and there seem to be several reasons why the engine did not do as well as was expected. The use of higher boiler pressure and probably a different setting of the valves would have been advisable. The facts are that the engine was entirely new and had not been sufficiently long in service to run smoothly. The valve gear and boiler were of unusual design and to expect the best combination of operating conditions to be determined upon for the first experiment would be rather unreasonable. Furthermore, for reasons not necessary to explain, the designer of the engine was not present at the tests nor had he any part in planning or executing them. The engine tests will be left out of consideration until we have records of further tests, which we hope will be carried out.

The boiler, frames, running gear and tender of this engine are the same as when the engine was known as the A. G. Darwin. The valve gear is a modification of the Walshaert, and the valves are similar in general construction to those used in the other engines of Mr. Strong's design. The boiler has been in use for a number of years, and was originally built for comparison with those of much lighter engines than are now considered up to date. The boiler has two Fox corrugated furnaces united at the forward ends by a corrugated combustion chamber or connection piece, at the forward end of which is the rear tube sheet. The tubes, 204 in number, are 10 feet 6 inches long and 2 inches outside diameter. The total heating surface of the engine is 1,280 square feet, and the grate area is 43.3 square feet. The test was carried out in connection with the counterbalance test on the locomotive testing plant at Purdue, and the usual methods of conducting such tests were followed. The coal was Brazil block and was perfectly dry, having been stored under roof for eight months. The analysis gave 51.09 per cent. fixed carbon, 38.93 volatile matter, 2.35 combined moisture and 7.63 per cent. of ash. The fire was very thin, a thickness of 3 inches being all that was found necessary, except when the greatest power was developed, when the thickness was about doubled. A peculiarity of the double firebox showed itself in the test. The fire was so clear that it was possible to see through the firebox and into the combustion chamber beyond when one of the fire doors was opened. The dimensions of the old laboratory locomotive, now known as Schenectady No. 1, which was formerly at Purdue, were such as to permit of very fair comparisons between an engine of ordinary construction and the balanced compound, and this is fortunate, for there are few tests which may be as easily compared. The heating surface of Schenectady was 1,214 square feet, as against 1,280 of the balanced engine, and the boiler pressure of the simple engine was 10 pounds lower than that of the compound. This pressure, however, will be seen to be far below good practice with compounds.

The balanced engine carries more water in its boiler, about 20,000 pounds weight of water, than the simple engine and it was shown in the test that it was very much less responsive to changes in the condition of the fire. This is not attributed to any of the peculiarities in construction, and it seems probable that if the water level could have been made lower with safety this effect would not have been so marked. The steam was not wetter than is usually found in locomotives, although considerable water appears to have been carried over into the cylinders after each stop.

The boiler may be classed in the wide firebox type, and the large grate area combined with the advantage obtained through having two fire doors, only one of which is opened at a time, would lead to the expectation of good evaporative performance; but the test showed not only a good evaporative performance, but an enormous capacity for evaporating water. The greatest evaporation amounted to 21,736 pounds of water per hour, which, as Professor Goss shows in his report, is equivalent to an evaporation of over 16 pounds of water per square foot of heating surface per hour. Mr. Strong states that the same boiler when tried in previous tests evaporated 6,000 gallons of water per hour, or nearly twice as much as Professor Goss shows in his test. This would appear to indicate that Professor Goss' figures do not by any means show the greatest evaporative capacity of the boiler. The highest record for water-tube boilers is believed to be 18.2 pounds of water per square foot of heating surface. This high rate was obtained on a Mosher boiler with a blast pressure of 12 inches of water. The balanced locomotive developed a horse-power on less than 2 feet of heating surface. The comparison of these figures with results obtained with the ordinary firebox boiler are marked. Professor Goss shows that the greatest amount of water ever evaporated in the boiler of Schenectady in an hour was 14,937 pounds, corresponding to 12.3 pounds per square foot of heating surface, or nearly 25 per cent. less than the balanced engine. Prof. Goss says: "Basing the comparison upon heating surface, therefore, it would appear that the capacity of the balanced locomotive boiler is more than one-third greater than that of a boiler having the same extent of heating surface of the ordinary type."

A corresponding effect on the evaporative efficiency would be expected, and in this the result is not disappointing. The equivalent evaporation per pound of coal went as high as nine pounds, and with but one slight exception it was always above eight pounds. This is contrary to previous experiences with locomotive and marine boilers, which, when forced, usually drop off very greatly in efficiency. An increase of 380 per cent. in the boiler power of the U.S. S. *Cushing* was accompanied by a reduction of economy of 45 per cent., and the efficiency of the boiler of Schenectady, when burning coal at the rate of 3,000 pounds per hour, is only about 60 per cent. of that shown when burning 600 pounds per hour. The case of the balanced engine, however, is noteworthy in that it gives about 90 per cent. of its maximum efficiency when burning coal at the rate of 3,000 pounds per hour. The rate of combustion was only about 75 pounds of coal per square foot of grate per hour, which is sufficient to account for much of the economy, but there must be other contributory causes for it. The fires were thin, as has been stated, and from the accounts of the tests there seems to have been no trouble to keep the grates properly covered. This bears out previous records of the same boiler with the old cylinders. The draft was light and Professor Goss says: "If the draft for the two locomotives were compared on the basis of pounds of steam generated per unit of time, the showing would be even more favorable to the balanced locomotive. Thus, if both boilers were required to deliver 10,000 pounds of steam per hour, the balanced engine would require but about half the draft which Schenectady would need." The smokebox temperatures were as high for the balanced engine as for the other, which would appear to indicate that more heat might be abstracted by the tube portion of the boiler. There was very little smoke from the balanced engine. The conclusions reached by Professor Goss with regard to the boiler are summed up as follows:

The evaporative efficiency is high, exceeding that of the ordinary firebox boiler by an amount varying from 8 per cent. to 60 per cent., depending upon the power developed. The difference in evaporative efficiency in favor of the balanced locomotive, when compared with that of Schenectady, is greatest when the

power developed is greatest. The steam supplied by the boiler under constant conditions of running is as dry as that usually delivered from the boilers of locomotives. The capacity of the boiler is very high when compared with ordinary locomotive boilers having the same amount of heating surface. It is not known how its capacity compares with that of other boilers of the same weight. The strength of the boiler, assuming 150 pounds to be its safe maximum of pressure, is not sufficient to give the highest success in compound locomotive work. The behavior of the boiler resembles that of a stationary plant. It does not respond quickly to changes in the condition of the fire.

The boiler is probably safe at from 175 to 200 pounds pressure and it is evident that the forte of this boiler is in heavy loads. The work done by the boiler is specially interesting in view of the use of corrugated furnaces. The average gain in efficiency over a simple engine was stated in the report to be 14 per cent., which is an excellent showing under the circumstances. This result may be credited almost entirely to the boiler and the engine may give a better account of itself later.

NOTES.

Electrical cab service was successfully inaugurated in London August 23. The automobile carriage has been slow in coming before the English public, but it has at last been received cordially.

The 24-hour system of notation which is in use on the Intercolonial and Canadian Pacific Railways has been adopted by the Belgian government for its railroads.

The locomotives of the Wilmington & Northern Railroad that are fitted with electric headlights have also been equipped with electric lamps for the cab gages operated from the dynamo circuits.

A heavy passenger train in England, according to Mr. Charles Rous-Marten, is one that weighs 247 tons, and in the estimation of Mr. Geo. F. Bird, writing in *Cassier's Magazine*, one weighing 210 tons is a rather remarkable load.

The Boston subway was put into successful and satisfactory service on September 1. The entire work is not complete; the portion along the Common is the only part finished. The experiment is being watched with greatest interest.

Another torpedo boat, the *Rodgers*, is reported to have failed to meet the contract requirements at the first and second trials. The speed required was 24½ knots, and an accident to the machinery stopped the second trial. This sounds like the reports from the *Dupont* when undergoing the speed trials.

Some hemlock timbers 2 feet 6 inches square by 55 feet long were found in excavating for the South Union Station in Boston. It is supposed that this material has been buried for over a hundred years. It is perfectly sound and will be used again.

At the Alma Tube Works, of Walsall, England, the mill furnaces are heated by gas from producers, and an interesting feature of the method used is that the gas passes direct from the producers to the furnaces without being allowed to cool down, the furnace and producer being in one. The air is passed through a regenerator and considerable saving is found from the practice.

The recent establishment of railroad cab service by the Pennsylvania Railroad in New York City has been followed by the New York Cental & Hudson River and the Erie railroads by the introduction of a zone system of cheap carriage service. The prices will range from 25 cents to one dollar in zones of about 20 blocks radius. The carriages will be available for patrons of the road only and the plan appears to have been very well received.

The independent air pumps of the battleship *Massachusetts*, which are of the Blake duplex pattern, have been shown to require but one-eighth of one per cent. of the power of the main propelling engines of the ship. This is a remarkably low proportion. They hold a vacuum of 25 inches when running at a speed of 17 double strokes per minute, the slow speed constituting a strong recommendation for this type of air pump.

The practical advantages of feed-water heating and also of condensing were shown by Mr. G. C. Cunningham at the Toronto meeting of the British Association. He said that by using Green economizers in an electric railway plant the feed water was heated to 250 degrees and was introduced at a pressure of 15 pounds. The value of condensing was given as the difference between 3.67 and 2.60 pounds of coal per horse-power hour.

The application of the time unit in connection with locomotive performance sheets is discussed by Geo. S. Hodgins in the *Railway Master Mechanic*. It is advocated in order to give due credit to the hardest worked engines. The ordinary terms are indefinite on account of omitting to take account of the length of time occupied in making the reported number of ton miles. The usual method is like expressing power with the omission of the factor of time, which is of course an absurdity.

The success and standing of a national organization of engineers—and this applies equally well to all technical organizations—depends very largely upon the work of the secretary. It is interesting to note that the Institution of Mechanical Engineers (England) has recently accepted the resignation of Mr. Alfred Bache, who has for over 43 years been its secretary, and who now retires on account of ill-health. The appreciation of his disinterested efforts in behalf of the Institution was expressed by a testimonial in the form of $15,000.

It is stated that the Japanese have made some remarkable experiments in connection with the best means of strengthening a hull against torpedo attack. Two hulls were prepared, each with an inner shell, the space between the two being in one case left empty, and in the other packed with bamboo. On exploding equal charges against the outer shell of each, the first-named hull had both outer and inner skins wrecked, while in the second case the inner skin escaped injury almost completely, though the bamboo packing was reduced to shreds.

A pneumatic attachment for opening locomotive cylinder cocks has been patented by Mr. J. W. Thomas, Jr., Assistant General Manager of the Nashville, Chattanooga & St. Louis Railway. A spiral spring tends to open the cocks, and the air pressure from the main reservoir acting on a small piston holds them closed. A small valve is provided so that the device may be operated by the engineman, and if the air pressure falls below 65 pounds the spring opens the cocks automatically and notifies him of the fact.

The English way of signaling railroads is admirably thorough, but it is fair to ask whether even such a good thing may not be overdone. The London & Northwestern, according to *The Railway Magazine*, has 17,000 signals lighted every night upon its lines, and a runner in taking a train from London to Crewe and back for his day's work is controlled by no less than 570 signals. Twenty-two semaphores upon a single bridge spanning four tracks is putting them in rather thickly, and the picture such a bridge presents is a striking argument in favor of simple signaling.

The most successful managers, says a sensible writer in *Machinery*, are those who manage men, not things. By selecting the right heads of departments, encouraging them to do their best by showing in a substantial manner that their work is appreciated, and devoting the time that is too often spent in trifling details in becoming familiar with the latest practice and methods, the manager or superintendent can suggest improvements to the various departments that far outweigh the whole cost of some of the details referred to.

An act intended to bring accidents on street railways under State supervision and responsibility took effect in Massachusetts recently. It provides that the inspectors appointed by the Railroad Commissioners to examine the roadbeds, tracks, stations, rolling stock, etc., of railroads, shall perform these duties with respect to street railways also, and in case the inspector finds any portion of the equipment of street railways to be not in strict compliance with law, or in a condition such as to endanger the safety of the public or employees, he shall so report in writing to the Commissioners, who are empowered to act accordingly. The inspectors also investigate and report all serious accidents.

The increasing use of steel in places where wrought iron was formerly employed has given rise to considerable difficulty when the steel returns to the scrap pile, because in working over the scrap, steel and iron will not mix under the hammer and bad welding results. To guard against this several roads make a practice of specifying that all steel used in car construction or similar work shall have the letter "S" stamped thereon in such a way as to enable the men in charge of the scrap to positively identify it. This is good practice, for the reason that it is almost impossible to distinguish steel from wrought iron by any tests except chemical ones.

It is not generally known, says the *Engineering and Mining Journal*, that James Watt proposed in 1783 a decimal system of weights and measures, but W. H. Preece, the eminent electrician, called attention to this in a lecture delivered at Greenock, Scotland, several months ago. Watt's unit length was based on the seconds pendulum; his unit weight was to be the unit cube filled with water. Watt visited Paris in 1786, and met La Place, Monge and other members of the committee of the Academy, who were then considering the question, and it is not unlikely that his ideas were used in the formulation of the existing metric system, which was adopted in 1801. The lengths of a seconds pendulum in the latitude of London does not vary much from a meter.

The business handled by the baggage department of the Union Station in Boston has been unusually extensive during the return of summer travel from the White Mountains and the shore resorts. The first week in September was phenomenal in this respect, the number of pieces of baggage handled having been more than 40,000. During the same week nearly 1,500 bicycles were checked. During the season now closing 22,146 bicycles have been checked. A good plan is followed in sorting trunks by check numbers. On the outside platform of the outward baggage room the space is divided into sections numbered from 1 through the various figures and ending with 0. A trunk having a check ending with the figure 7, for instance, like 14027, is placed in section 7; any check with a cypher for its final figure, like 75330, for example, is placed under 0 in the platform sections. In this way a baggageman can readily find any wished-for trunk, and much time may be saved, as well as temper, for it has been found by the baggagemen that the question of temper enters largely into the work of checking and handling of baggage.

In accordance with the desire of the Secretary of Agriculture to promote more extended experiments in the use of steel trackways on wagon roads, the office of Road Inquiries has made arrangements with the Cambria Iron Works, of Johnstown, Pa., for rolling special rails for this purpose, these arrangements to go into effect as soon as definite orders from responsible parties amounting to one mile of track are received. The directors of the Road Inquiry and engineers of the iron company, after much discussion, have, according to the New York *Sun*, agreed upon a plan of track which promises to meet all requirements. It uses no wood in construction, and no cross-ties for support, but consists of a simple inverted trough or channel of steel for each wheel, with a slightly raised head on the inside to guide the wheels, each channel resting in a bed of gravel, and the two tied together occasionally to prevent spreading. Special devices for remounting are provided at each joint. The bearing, or tread for wheels, is 3 inches wide, the thickness about $\frac{7}{16}$ of an inch. The weight of the structure is about 100 tons per mile of single-track road, and it will be furnished in small sections at the rate of $3,500 per mile. The first order for track has been given by the New York State Agricultural Experiment Station.

The limited number of gas engines in use in America may be chiefly attributed to three causes; the high first cost compared with steam engines, the high price of gas and cheap coal. These conditions are changing rapidly, and are much more favorable than they were a few years ago. Coal in many places is dearer, wood is scarce, gas is much cheaper, and gas engines are better and much lower in cost. Formerly there were but one or two firms engaged in the manufacture of gas engines, and those of but small capacity. Now there are in America about 50 manufacturers bidding for work; many of them manufacturing but small units, while others are manufacturing engines as large as 100 horse-power, and if required are willing to undertake an installation as high as 750 horse-power. Perhaps the most notable installation in the world of a gas engine electric lighting station is at Belfast, Ireland, says W. F. Kelley. This municipality owns the gas plant, as well as the lighting station. It contains four 120 horse-power tandem double acting, two 60 horse-power single double acting and two 150 horse-power four-cylinder vertical single acting high speed gas engines. Reports from the engineer in charge show that the service has proven very satisfactory, and as gas is furnished at cost, the operation is more economical than any other form of motive power.

The deepest bore hole in existence is said to be at Parnschowitz, near Rybrick, Upper Silesia. It is 6,571 feet below the surface of the soil, and was made in a search for coal measures. The hole, according to *The Engineer*, was 12 inches in diameter at the beginning, and this was lined with a tube about 0.4 inch thick; at a depth of 230 feet, the bore was reduced to 8¼ inches in diameter, and thus continued for 351 feet. The greatest difficulty encountered was the great weight of the boring rods as the depth increased. Though steel was used at a depth of 6,560 feet, the total weight of the tools reached 30,155 pounds. Under this weight ruptures of the rods were frequent, and an accident of this nature finally stopped the work; about 4,500 feet of rods fell to the bottom, and, being jammed under a part of the tubing, it it was impossible to withdraw it. The diameter of the well at bottom was 2¾ inches. Temperature observations made showed 12 degrees Cent., or 53.6 degrees Fahr., at the surface, and at the depth of 6,571 feet the temperature reached 69.3 degrees Cent., or 157 degrees Fahr. This is equivalent to an average augmentation of heat of 1 degree Cent. for every 34.14 metres of depth, or 1 degree Fahr. for every 63 feet. These figures differ slightly from those obtained in other deep borings. The increase of heat at Schladebach correspond to 1 degree Cent. in 35.45 metres; that at Sperenberg, near Berlin, to 1 degree Cent. in 32.51 metres; and at the artesian well of Grenelle, at Paris, which is only 1,797 feet deep, and furnishes water at a temperature of 27.70 degrees Cent., it is estimated that the increase of heat is equivalent to 1 degree Cent. in 31.83 metres.

Many proprietors of manufacturing plants look upon efficiency tests of steam plants which are working satisfactorily as unimportant and unnecessary; at least this is a fair inference to draw from the relatively small number of such tests that are made. In a large shop or mill an expert mechanical engineer can usually find so many ways in which money is leaking away as to make it worth while to employ him at regular intervals to look over the plant and report upon the practice followed. A well-known engineer who was recently examining a number of factory institutions discovered that in one of them a great deal more coal was used when the night fireman was on duty than the day man used in the same length of time, and the average horse-power during the day was somewhat larger than that of the night time. When this was remedied the plant was operated with a considerable saving over the former practice. This waste is but too common, and it may be said that only a thorough study of the operation of a plant would reveal such things. A tendency of manufacturing establishments is to grow up about the original plant and to increase by additions in a manner very much like the ordinary growth of a railroad switching or storage yard, without any definite system and without any thought of the wastefulness of the scattered elements and unnecessary duplications in the plant. One small factory plant comes to mind as an excellent illustration of this. The business had started in a small way about 15 years ago and now is a flourishing industry requiring more than four times the amount of steam power originally found adequate. Instead of putting this all into a single steam plant, which might easily have been done with the layout available, there are four small boiler plants and as many small engines. Comment upon this practice

is unnecessary; an examination by an engineer would enable this concern to save a great deal of money. To quote what is probably an extreme case, Mr. Charles E. Emery in a paper read before the American Society of Mechanical Engineers in 1895 showed how he was able to reduce the annual coal consumption of a large oil refinery from 64,000 tons to 32,000 tons. To do this he closed up one of four boiler houses.

Personals.

Mr. Edwin McNeill has retired from the Presidency of the Oregon Railroad & Navigation Co.

Mr. J. S. Chambers, Master Mechanic of the Illinois Central at Paducah, Ky., resigned Sept. 15.

Mr. R. L. Ettinger has been appointed Mechanical Engineer of the Big Four at Indianapolis, to succeed Mr. Mason Rickert, promoted.

Mr. W. P. Orland has been appointed Master Mechanic of the St. Louis Division of the Big Four, vice Mr. G. S. McKee, resigned.

Mr. H. A. Gillis, late Master Mechanic of the Norfolk & Western, has been appointed General Superintendent of the Richmond Locomotive Works.

Mr. H. G. Hudson has been appointed Master Mechanic of the Cairo Division of the Big Four, with headquarters at Mount Carmel, Ill., vice Mr. W. P. Orland, transferred.

Mr. A. L. Moler, formerly with the Cincinnati, Hamilton & Dayton, has been appointed Master Mechanic of the St. Louis, Peoria & Northern, with headquarters at Springfield, Ill.

Mr. W. E. Killen, Master Mechanic of the St. Louis, Chicago & St. Paul, has also been appointed Master Mechanic of the Chicago, Peoria & St. Louis; headquarters, Springfield, Ill.

Mr. W. J. Hemphill, Superintendent of Machinery of the Chicago, Peoria & St. Louis Railway, has resigned, to engage in the manufacture of woven wire fence at Jacksonville, Ill.

Mr. John S Thurman has been appointed Mechanical Engineer of the Missouri Pacific, St. Louis, Iron Mountain & Southern and Leased Lines, with headquarters at St. Louis.

Mr. Russell Sage has retired from the Presidency of the Iowa Central, and is succeeded by Mr. Horace J. Morse, of New York. Mr. Morse has been connected with the road for many years.

Mr. D. A. Fell, Sr., for several years Master Car Builder for the Lehigh & Susquehanna Division of the Central Railroad of New Jersey, died suddenly at his home in Wilkes-Barre, Pa., Aug. 27, at the age of 80.

Mr. Mason Rickett, formerly Assistant Mechanical Engineer of the Cleveland, Cincinnati, Chicago & St. Louis, has been appointed Master Mechanic of that road at Delaware, O., effective Sept. 1, to succeed Mr. J. A. Keegan.

Mr. David Patterson has been appointed Master Mechanic of the Southern Division of the Kansas City, Pittsburgh & Gulf, with headquarters at Shreveport, La. His jurisdiction will extend from Mena, Ark., to Port Arthur, Tex.

Mr. C. L. Mayne has been appointed General Superintendent of the Fitchburg, with headquartars in Boston, Mass., to succeed W. D. Ewing, resigned. Mr. Mayne was appointed Assistant Superintendent of the road several months ago.

Mr. E. W. Haves has resigned as Superintendent of Motive Power of Machinery of the Fort Worth & Denver City at Fort Worth, Tex., and is succeeded by Mr. George K. Jackson, formerly Foreman of the shops at Wichita Falls, Tex.

Mr. Nat C. Dean, formerly with the Crane Company of Chicago, has been appointed Western Representative of the Fox Pressed Steel Equipment Company and the Carbon Steel Company, and will have offices at 1413 Fisher Building, Chicago.

Mr. Fred Mertsheimer has accepted the position of Superintendent of Motive Power of the Kansas City, Pittsburg & Gulf, with headquarters at Kansas City. Mr. Jas. Roberts, General Foreman of the Union Pacific shops at Armstrong, Kan., succeeds him.

Mr. Peter H. Schreiber, Master Mechanic of the Chattanooga division of the Cincinnati, New Orleans & Texas Pacific, died at Chattanooga, Tenn., Sept. 9, from a stroke of apoplexy. He was born at Whitehall, Pa., July 24, 1851, and had been in railway service since 1869.

Mr. C F. Quincy, of the Q & C Company, Chicago, has been elected one of the Directors of the Iowa Central and also has been appointed Honorary Commissioner, for the State of Illinois, to the Trans-Mississippi and International Exposition to be held at Omaha, Neb., in 1898.

Mr. A. S. Cheever has resigned as Chief Engineer of the Fitchburg Railroad to engage in other business at Cleveland, O. He has been with the road for 17 years and has been Chief Engineer since November, 1890. Mr. F. O. Melcher, formerly Assistant Engineer, has succeeded him.

Benjamin Brewster, First Vice-President of the Chicago, Rock Island & Pacific, diedat his summer residence at Casenovia, N. Y., Sept. 4, at the age of 69 years. For a number of years he was President of the Keokuk & Des Moines, which is leased to the Chicago, Rock Island & Pacific.

The Hon. Thomas Rees Morgan, machinist, inventor and manufacturer, died suddenly of heart failure at his residence on Monday, Sept. 6. Mr. Morgen was born in Pennydarran, Merthyr Tydvil, Glamorganshire, Wales, March 31, 1834. At the time of his death he was President and principal owner of the Morgan Engineering Company, Alliance, O., and was a leading manufacturer.

It gives us pleasure to note that Mr. W. H. Elliott, Signal Engineer of the Chicago, Milwaukee & St. Paul, who has heretofore reported to the Mechanical Engineer of that road, now reports direct to the General Superintendent. This constitutes a substantial, encouraging recognition of the importance of signaling, and, while Mr. Elliott's duties are unchanged, it must necessarily prove advantageous to transact the business of the signal department as directly with the general officers as possible.

Books Received.

TENTH ANNUAL REPORT of the Board of Mediation and Arbitration of the State of New York, 1897.

POOR'S MANUAL OF RAILROADS, 1897. Thirtieth annual number. H. V. & H. W. Poor, New York.

MODERN LOCOMOTIVES. Illustrations, Specifications and Details of Typical American and European Steam and Electric Locomotives, 1897. Published by the *Railroad Gazette*, 32 Park Place, New York. This book will be reviewed next month.

UNIVERSAL DIRECTORY of Railway Officials, 1897. The Directory Publishing Company, 8 Catherine street, Strand, London.

SOME FUNDAMENTAL PROPOSITIONS RELATING TO THE DESIGN OF FRAMEWORKS. By Frank H. Cilley, S. B. Reprinted from the *Technology Quarterly*. Vol. X., No. 2. June, 1897.

New Publications.

MAXIMUM STRESSES IN FRAMED BRIDGES. By William Cain, Member Am. Soc. C. E., Professor of Mathematics in the University of North Carolina. Van Nostrand's Science Series No. 38. Pp. 182; cloth. New York: D. Van Nostrand Company, 1897.

The first edition of this work was published in Van Nostrand's Magazine, in 1878, and had to do chiefly with the comparison of the weights of bridges and their most economical depths. These subjects have now been practically solved by bridge engineers, with the result of replacing many types that were formerly quite common with other forms that grew out of the older ones. The book in hand discusses the stresses in those types most used at present, both as to uniform and wheel loads. It is to be considered as either an independent short treatise or as an introduction to the larger treatises. The subject matter is arranged for the benefit of

students and is given in considerable detail. The explanations are accompanied by examples specially designed to bring out the ideas involved. The principal types of bridges treated are the Pratt and Howe trusses for through bridges and for deck spans, the Whipple and the lattice trusses and the Warren girder. An appendix presents the subject: Most economical height of trusses having parallel chords.

RAILWAY TRACK AND TRACK WORK. By E. E. Russell Tratman, A. M. Am. Soc. C. E., Associate Editor of *Engineering News*. 400 pages, over 200 illustrations; bound in red buckram. The *Engineering News* Publishing Company. New York, 1897. Price $3.

This work has been a long time in preparation, and those who have been watching for its appearance will not be disappointed. It deals with the materials and standards of track construction and maintenance, and fills a long-felt want because there is no other modern book treating so fully of these subjects. While the requirements of engineers and roadmasters are given first consideration, the book will be very valuable to operating officers. Roadbed construction is treated in detail, and a great deal of attention is given to track material, rails, ties, rail joints, switches, frogs, fences, cattle guards and track tools. A number of subjects allied more or less closely to the subject of tracks have been considered, such, for instance, as bridge floors, coal and wafer stations, turntables, section houses and track signs. All of the foregoing subjects constitute Part I., and Part II. is devoted to track work, the chief divisions of the subject being as follows: Organization of the maintenance of way department, track laying and ballasting, drainage and ditching, track work for maintenance of gage, grades and curves, inspection and premium systems, switch, bridge and telegraph work, handling and clearing snow, wrecking, records and reports. There are also chapters discussing the relation of the track to the traffic which it carries, the protection of grade crossings and the design of yards. It will be seen that the book is comprehensive, and in fact it is a little too much so in some particulars. For example, the subject of railroad crossing protection by interlocking is a broad one of itself and is not to be properly handled by anyone in a few pages. A paragraph would have sufficed to show the relations between the track department and the maintenance of signals. The selection of the Gibbs system of protecting a crossing of a steam and a street railroad as an example of crossing protection appears strange, inasmuch as a less general application of interlocking principles could hardly be found. The subject of the construction of coal chutes, like that of interlocking, is interesting, and both add to the interest of the work, but the appropriateness of including these in a work on track is questionable. The only other criticism offered here is in the treatment of special devices. The author has selected several examples of a line of specialties with the effect of giving endorsement to only those shown. This method and the giving of names and addresses of manufacturers attracts attention to specific devices instead of to general principles for which such a book should and will be consulted. The book is so good and carries out its plan so well that these criticisms appear exceedingly small, yet they seem to be called for. The author is entirely at home when he is dealing with track and track methods, and in this particular the book seems to be destined to be a classic. He is an engineer writing for engineers, and he writes well. He is not dogmatic in regard to debated questions of practice, and he has evidently tried to make the value of the book as permanent as possible. With the slight exceptions noted he has succeeded admirably. It is not too much to say that no officer of a railroad having to do with track work in any of its branches can be up to date without this book. It is well indexed, well printed and bound and the illustrations are better than we have ever seen in a work of this character. They are uniformly excellent and are all that can be desired. While they are not large, they are perfectly clear and distinct, especially as to the dimensioning of working drawings. Two valuable tables of standard tracks on 53 railroads of the United States in the form of appendices complete the book.

THE ENGINEER'S SKETCH BOOK OF MECHANICAL MOVEMENTS, DEVICES, APPLIANCES, CONTRIVANCES AND DETAILS EMPLOYED IN THE DESIGN AND CONSTRUCTION OF MACHINERY FOR EVERY PURPOSE. By Thomas Walter Barber, Engineer. Third edition considerably enlarged. With 2,603 illustrations, descriptive notes and memoranda. London: E. & F. N. Spon. New York: Spon & Chamberlain, 12 Cortlandt street. 1897. Price, $4.

That this book has already been through two editions speaks for its value to those for whose use it was prepared. The author has put his experience of 25 years in the preparation of sketches and notes concerning mechanical movements and details of machine design into an exceedingly convenient form for the use of draftsmen to whom a mere suggestion of the way to reach a certain result is sufficient. In designing machinery the draftsman must rely chiefly upon his memory for ways of reaching certain results which he is seeking, and he is likely to run in ruts and not employ devices with which he has not personally come into contact. The author says, in the preface, that it is presented "in the hope that it will be found of service to others who are engaged in the head-splitting, exhausting work of scheming and devising machinery than which I can conceive of no head work more wearing and anxious." The book gives simple sketches on every right-hand page and a mere line or two of description on the opposite page, the sketches and descriptions being given corresponding numbers. "A sketch," the author says, "properly executed is to a practical man worth a folio of description, and it is to such that these pages are addressed." No attempt is made to give strength or dimensions. The additions are in the latter part of the book and constitute Part II., references being given to the sketches in Part I. We are glad to have the book in our library, and also to recommend it to draftsmen. To illustrate its use: Suppose a man to be designing a crane of some kind, he would find it exceedingly convenient to turn to this book and find forty-three outline sketches of cranes of various types, locomotive, floating and stationary, and it is likely that he would receive a suggestion or two from them. The list of sketches is weak in places, but taken as a whole it is a very valuable book for its special purpose. In these days of good engravings it is too bad that the cuts were not better executed.

PROCEEDINGS OF THE MASTER CAR BUILDERS' ASSOCIATION, Vol. 31. John W. Cloud, Secretary, Chicago. Price, $1.50.

There is little to be said about this volume that has not already been said about previous volumes of the proceedings. It is from the press of the Henry O. Shepard Company, and is well printed, well illustrated and well bound. The subjects of the discussions have been brought to the attention of our readers through the reports of the convention at Old Point Comfort last June, and the prompt appearance of the official proceedings will please many people. Mr. Cloud and his assistants should be credited with more rapid work in getting out the proceedings of the Master Mechanics' and the Master Car Builders' Associations than is performed by the secretary of any other technical organization.

PRACTICAL HINTS FOR LIGHT RAILWAYS AT HOME AND ABROAD. By F. R. Johnson, M. Inst. C. E., F. R. G. S., Late Executive Engineer Assam Bengal Railway. 31 pp., illustrated. London: E. & F. N. Spon. New York: Spon & Chamberlain, 12 Cortlandt street. Price, $1.00.

This work is what its title indicates, a collection of hints for the construction and operation of light railways. The author is experienced in Indian railroad building and operation, and uses positive terms in regard to his suggestions. He advocates a gage of 2 feet or 2 feet 6 inches, and speeds of from 8 to 12 miles per hour as having the best chances of success, and does not appear to appreciate any advantage to be gained from using the gage, which is standard in the country in which the light railroads are built. Mr. Johnson prefers curves of 198, 330 and 660 feet radius, and ballast from 5 feet wide by 9 inches deep to 6 feet wide and 1 foot deep. The rails recommended are 35 pounds per yard and the wheel loads from 2½ to 3 tons per wheel. The subjects of rolling stock, trading and transshipment facilities, station equipment, cost and working complete the hints, and an appendix contains a resolution of the government of India regarding concessions for feeder railroads.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

PORTABLE RAILWAY MATERIAL.—An eight-page pamphlet has been received from Arthur Koppel, manufacturer of portable railway material. It contains an illustrated description of Mr. Koppel's patented electric railway equipment. This system employs a portable track made in sections, to which the overhead trolley supports are secured at the proper intervals. The system was designed with a view of cheapness and adaptability to the field of light railways. The system includes an electric motor car, costing considerably less than a steam locomotive that is capable of hauling the

same load, and the electric motor car weighs less and will run satisfactorily on lighter rails. The pamphlet is interesting and shows the whole system, including the method of erecting the trolley wire. Mr. Koppel's address is 80 Broad street, New York.

The International Correspondence Schools, of Scranton, Pa., have sent us two pamphlets, one containing 1,000 testimonials from students, and the other containing information concerning the schools and the system of study. The testimonials are conveniently arranged alphabetically under the city in which the student sending the testimonial lives, whereby a prospective student may easily ascertain whether there are any of these in his vicinity. The other pamphlet contains a description of the courses of instruction, a list of the instructors, a history of the schools and a full description of the methods employed, which are admirably adapted to the requirements of those who for want of time and means are unable to attend the regular technical schools. The requirements of admission, rules for enrolling, prices of scholarships and other expenses are included. A second part is devoted to the details of the courses of study, and anyone who is not informed as to the work of these unique schools should take the trouble to look them up.

THE NEWBURGH ICE MACHINE AND ENGINE COMPANY, Newburgh, N. Y., has just issued a neat little catalogue of 64 pages, containing descriptions of Penney's ammonia ice machines, the new Pictet-oxide system, Whitehill-Corliss engines and steam power plants. This concern is managed by men who have long been identified with the ice machine and engine building interests, and are experts in their specialties. The pamphlet records the experience of the officers of the company, describes the practice and theory of the mechanical ice machine, and illustrates and describes the machinery furnished by this company. It also presents some remarks upon Corliss engines, and contains a number of engravings of different types of engines taken from photographs representing the latest and best practice. A large catalogue containing more complete information and giving the names of users of the engines will be sent upon application.

THE DETROIT LUBRICATOR COMPANY, of Detroit, Mich., has just issued a new standard size 43 page pamphlet illustrating and describing sight feed lubricators, plain lubricators, brass and glass oilers, oil injectors, low-water indicators, globe and radiator valves and other devices of similar character. The lubricating devices are made chiefly for use on stationary and hoisting engines, steam pumps, gas engines, air compressors and in fact all kinds of engines. Those for locomotives are not illustrated in this catalogue. The necessity for giving careful attention to lubrication of valves of engines is pointedly shown by a quotation, with indicator diagrams, taken from Mr. E. M. Herr's remarks before the Western Railway Club in January of this year. This will interest all steam users, and it will probably astonish many who may see it in this catalogue for the first time. Mr. Herr shows a loss of 206 horse-power on account of defective lubrication of a locomotive valve. This catalogue will be sent to any address upon application.

"The Detroit & Mackinac Railway, which runs from Bay City north along the coast of Lake Huron, offers special inducements this year to all lovers of the rod and gun. The brook trout season just ended has been the most successful one ever enjoyed in Lower Michigan. The bass fishing still continues and is of the best. Duck may be shot in September. Partridge and quail are very plentiful this year along the line. Deer had a good winter and spring, and will be in good condition and plentiful from November 8 to 30 inclusive, which is the open season this year. The Detroit & Mackinac Railway claims to have the best hunting and fishing in Lower Michigan and has good grounds for the claim." For further particulars address J. D. Hawks, President, Detroit.

Among the advertising novelties soon to be issued by the B. & O. is one which is sure to attract a great deal of attention. It is to be known as "The Book of The Royal Blue," and is to be issued monthly by Col. D. B. Martin, Manager of Passenger Traffic. It will be magazine size, filled with attractive half-tone illustrations and reading matter descriptive of the road.

Compressed Air on Jerome Park Reservoir Work.

The Ingersoll-Sergeant Drill Company has just received an order from J. B. McDonald and Andrew Onderdonk, contractors of the Jerome Park Reservoir, New York, for a large air compressor plant, duplicating the plant now in service, except that the plant ordered is larger and has both steam and air cylinders compounded.

This reservoir is being built for the purpose of increasing the storage capacity of the water supply of New York City. The dimensions will be about 3,800 feet long and 2,800 feet wide, and the reservoir will be excavated to a depth of 33 feet 6 inches. It will be necessary to excavate 3,165,000 cubic yards of solid rock, an immense undertaking.

Almost every mechanical appliance on the work is operated by compressed air. The original plant consisted of one Ingersoll-Sergeant duplex Corliss condensing air compressor, with steam cylinders 24 and 44 by 48 inches, two air cylinders 24½ by 48 inches and capable of producing 540 horse power at the pressure of 80 pounds at the receiver. Fourteen drills, 14 hoisting engines and several pumps have been operated by the original plant exclusively by compressed air, and the additional plant will provide sufficient capacity to permit of doing all the work on that job by air power.

Von Borries Four-Cylinder Compound Locomotive.

[Translated for the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL from an article by Herr Von Borries in Glasers' Annalen.]

GENERAL DESCRIPTION.

The following description of the working parts of a compound locomotive having two high and two low pressure cylinders will make the construction of the machine quite clear.

The locomotive has a high and a low pressure cylinder upon each side which makes the construction and arrangement so simple that it can be cast in a single piece. The two pistons, on either side, drive an inside and an outside crank respectively, which are set nearly but not quite opposite to each other, so that the pistons are always moving in practically the opposite directions to each other, and thus the line of moving forces of the reciprocating parts with the weights of the same are equalized.

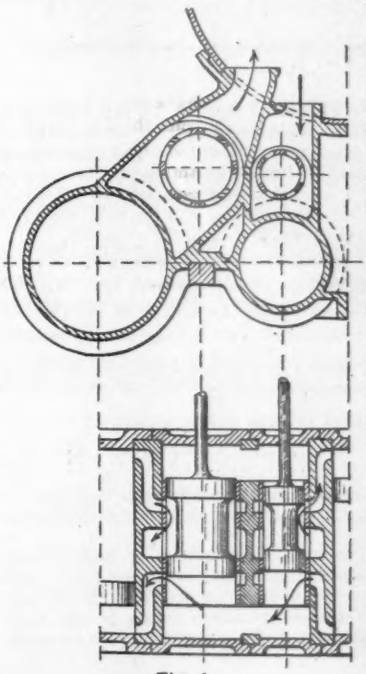


Fig. 1.

The two valves for each pair of cylinders are driven by a single valve motion, and the proper ratio of steam admission, upon which an economical use of the steam depends, is obtained by having two arrangements of valves. These valves are shown in Fig. 1, from which it will be seen that the valve of the high-pressure crank admits steam from the inside, while that of the low-pressure admits it from the outside.

In the first arrangement, as shown in Fig. 2, the crank of the low-pressure piston is opposite that of the corresponding high-pressure crank, with a slight angular advance in the direction of the rotation of the axle when the locomotive is moving ahead. This angular advance of the low-pressure crank brings it about that its piston reaches the end of its stroke a trifle earlier than the high-pressure piston, and its valve also has a little less outside lap than that of the high-pressure cylinder. The result of this smaller amount of lap is that the cut-off of the low-pressure cylinder occurs a little later in the stroke than that of the high-pressure cylinder.

Figure 3 shows the action of the valves by means of the Zeuner diagrams. *AB* is the stroke of the high-pressure and *CD* that of the low-pressure piston, set at an angle a with each other, as already mentioned. With an adjustment of the valve of the high-pressure cylinder which puts the point of cut off at a, for example (that is at half stroke), the valve of the low-pressure cylinder will be closed at the point b, with the crank in the position *OC*, so that the point of cut off will, in this instance, be equal to $\frac{Ce}{CD}$ (which, in the case in hand, will be about 0.7) and will be greater or later than the point of cut off of the high-pressure cylinder by the amount *Oe*. By a careful selection of the angle a

the proper anuglar advance to give the suitable cut-off ratio will be obtained.

For the valve motions shown, the openings of the valves are very different when the engine is backing, and this difference increases with the increase of the angle a. Hence, this angle should not be more than from five degrees to six degrees, since even with this a cut off of 40 per cent. in the high pressure cylinder will amount to 50 per cent. in the low-pressure, thus giving an actual expansion of the steam, before it is exhausted, of from 6 to 6½ times.

In the second arrangement the cranks are placed directly opposite each other; the steam valves of the two cylinders do not move together, however, but are driven from different points c and d of the main lever $a\ b$ of the valve motion, which is of the Heusinger von Waldegg type. The low-pressure valve-stem is attached at d, which is nearer to the connection of the radius bar than is that of the high-pressure valve-stem connection at c. With the same motion of the link s, the former has a shorter forward motion from the short arm of the lever $a\ d$ than has the

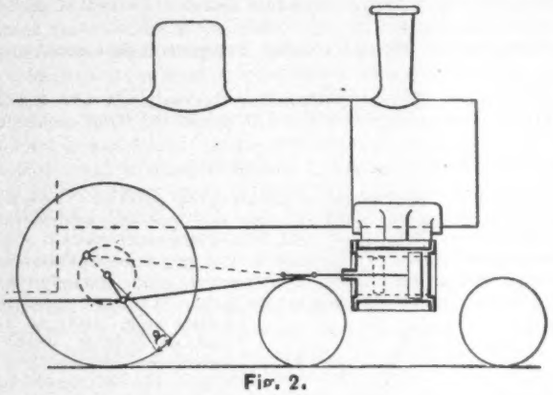


Fig. 2.

latter from the long arm $a\ c$. The first, having less lap, therefore cuts off later than the second. This is shown in Fig. 5 by means of a Zeuner diagram. For the same point of cut off the centers of the two valve circles lie at the same distances above and below the center line, making $O\ e = O\ g$, since these distances involve the same motion for each. But horizontally the center n of the low-pressure valve circle lies about $\frac{g\ n}{e\ m} = \frac{a\ d}{a\ c}$ (Fig. 4) nearer the center O than that of the high-pressure, and as it has less lap the point of cut off is correspondingly later. The diagram shows that the ratio of the forward motion $\frac{g\ n}{e\ m} = 0.7$, a ratio which would make the point of cut off 0.6 in the low-pressure cylinder when it is 0.4 in the high-pressure.

The following are the ratios of several points of cut off

High-pressure cylinder	0.3	0.4	0.5	0.7
Low-pressure cylinder	0.5	0.6	0.7	0.71

which gives the most economical steam distribution that can be obtained in this way when both running directions are taken into consideration.

In the place of the Hensinger von Waldegg valve motion any other, the Joy for example, which has a main working lever, can be used, and in the place of piston valves the ordinary flat valves may be employed. The two steam cylinders on each side may also be cast in two pieces if desired, and a planed surface be made between them.

COMPARISON OF THE NEW LOCOMOTIVES WITH THOSE HERETOFORE BUILT.

The new arrangement described above offers the following advantages over the ordinary compound locomotives that have, up to this time, been built.

1. In comparison with the two-cylinder compound locomotives it admits of the use of a larger low-pressure cylinder, a higher rate of expansion and a better utilization of the steam at high speeds, as well as a greater tractive power, with the same rate of of expansion, upon grades. With two cylinders the piston area cannot exceed certain moderate dimensions, because the dimensions would be inconvenient and the working parts too large. We are, therefore, obliged to be content with a steam expansion from five to six times, while with the four cylinders a rate of expansion of from six to seven and a half is easily obtained when the point of cut off in the high-pressure cylinder ranges from 0.3 to 0.4 of the piston stroke.

The steam passages in the low-pressure cylinder can be made larger relatively to the piston area, so that the loss of pressure due to high velocities is diminished and the economical use of the steam consequently improved.

As the working of the pistons of each pair is in opposite directions the journals of the main driving axles, as well as the frames, are freed from a considerable portion of the stresses usually put upon them, there is less for the side rods to do and friction and wear are considerably reduced. It is not necessary that any fore and aft play should be allowed in the axle boxes, pounding is thus lessened, and on account of the reduction in the slip of the wheels upon the rail the number of flat spots are reduced—spots which formerly necessitated frequent turning of the driving wheels and thus increased the cost of the maintenance of the locomotive.

Since the opposite motion given to the reciprocating masses balance each other to a great extent, it is necessary to put but a very light counterbalance in the driving wheels. The centrifugal force of the counterweight acting vertically, which, with the two outside cylinders, may amount to as much as from 20 to 25 per cent. of the whole weight on the wheels, at high speeds, and which therefore tends to increase and decrease that weight at each revolution, this force becomes quite insignificant, so that the slipping due to it is correspondingly decreased.

This internal balancing of the forces and masses of the working parts results in a very quiet working of the machine and one that is free from pounding, so that wear is lessened and the mileage between two overhaulings of the machine increased. Since the regular overhauling of the engine is determined by the necessity of turning the tires of the driving wheels and the wear of the working parts, the cost of maintaining a locomotive is lowered in proportion to this increase of mileage.

The draft upon the fire is more evenly equalized with the four blasts for each revolution of the driving wheels than it is with the two blasts of the two-cylinder compound locomotive. Hence the coal consumption is somewhat less and the steaming qualities of the boiler improved, especially at high speeds.

2. In comparison with the four-cylinder locomotives of the Glehn system the arrangement of the parts will be found to be very much simpler, since there is a saving of two complete sets of valve motions, and the two cylinders being cast in one piece greatly simplifies the work of construction.

The tendency of the main axle to bend is greater than in the Glehn system, so long as the working pressure of the outside piston is not taken up by the side rods, and transferred to a pair of trailing wheels. But when the locomotive is hard at work and a pair of trailing wheels are used, which is the case in most instances, the tendency to bend will not be essentially increased by the piston pressure. In any case, however, the tendency is less than in locomotives having two inside cylinders since the tractive power of those similarly located upon this locomotive is considerably less. When the great tendency of the driving wheels of these engines to twist and pound at high speeds are taken into consideration, the differences must become still less. The use of nickel steel in these axles has rendered them perfectly safe. In engines with six wheels coupled the front axle can be driven by the inside cylinders and the second by the outside, and thus a corresponding distribution of this tendency be obtained.

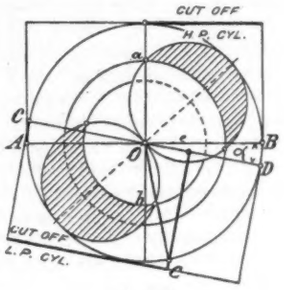


Fig. 3.

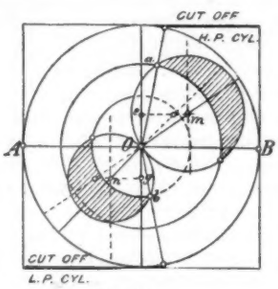


Fig. 5.

The working parts of the inside cylinders are as easy of access as the outside, because the outside cylinders are not in the way and the cross connections are between the frames. The construction of the frames is much simpler, which, being on the American plan, can be quickly disconnected from the cylinders.

On account of the important equalization of the opposite forces, at work upon the cranks, at the axle bearing and the corresponding steam pressures upon the cylinder heads of the two cylinders, the main frames and the cylinder fastenings can be correspondingly lighter.

The common steam chest, which serves as an intermediate receiver, avoids the loss of pressure and heat incident to the common construction of receiver. Thus the receiver pipe in the smokebox is done away with and without any loss, since its heating surface is so small that it is very inefficient.

The ratio of the point of cut off can be accurately adjusted to correspond to the relative areas of the two pistons and the speed of the engine, so that the most economical utilization of the steam will be obtained for both the forward and the backward motion by the arrangement of the Heusinger von Waldegg valve motion, as already described.

8. In comparison with the Vauclain four-cylinder compound locomotive as built by the Baldwin Locomotive Works, it has the advantage of being able to use an earlier point of cut off with less compression in the high-pressure cylinder, thus yielding a better utilization of the steam.

The principal defect in the Vauclain construction lies in the action of the heavy reciprocating parts moving in a horizontal line, which at the least calculation must be about twice as heavy as they would be upon two-cylinder locomotives. If, then, one-half of this weight is counterbalanced, the excess of weight due to the vertical component of the centrifugal force, when the wheels are making from 240 to 300 revolutions per minute, would range from 9,900 to 15,500 pounds. As the wheel weights must be increased and diminished by these forces at each revolution, it

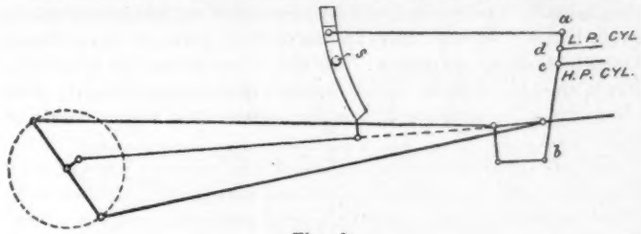


Fig. 4.

is evident that a very considerable stress must be put upon the track. In the design that has been described these forces are reduced to an insignificant quantity as the result of the equalization that is obtained.

The arguments against the use of crank axles should not enter into the consideration at all, since by the use of nickel steel they can be made perfectly safe and of ample strength.

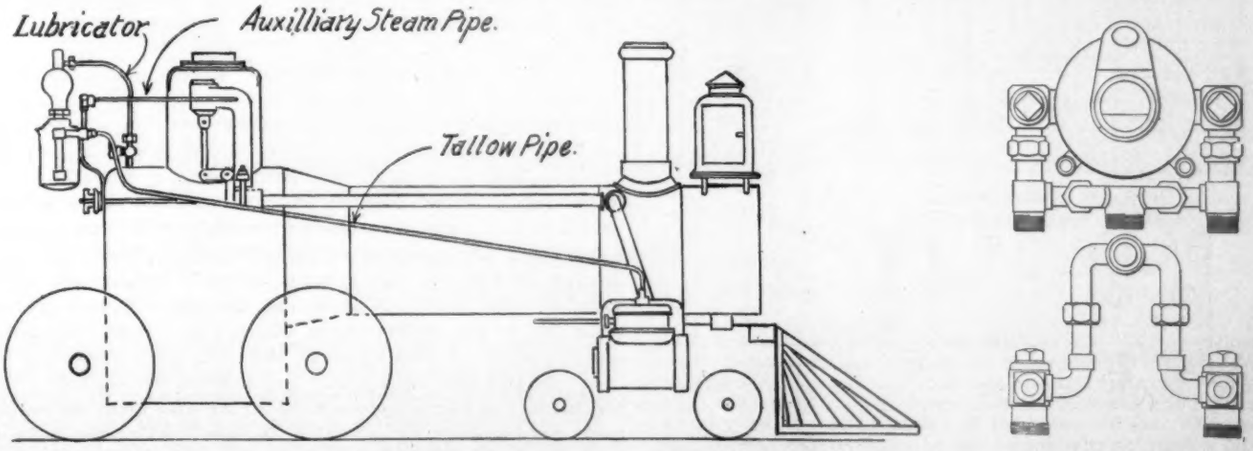
The disadvantages of this engine as compared with the Vauclain type lie in the increase in the number of parts, involving two valve seats, two stuffing boxes, two valve stems and two valves, while as an offset to this there is less strain upon the axle bearings and frames, as shown in comparison No. 2, and there is an entire avoidance of the tendency of the piston rods to bend and thus increase their own frictional resistance.

Lubrication of Locomotive Cylinders.

The fact that the manufacturers of locomotive sight-feed lubricators have been engaged upon the solution of the problem of getting oil down through the tallow pipes of locomotives while the throttle valve is open has been referred to in these pages. Our attention has been directed to a device brought out recently by the Detroit Lubricator Company for the purpose mentioned.

The engravings show the principal features of this improvement, known as the Tippett attachment, and in the opinion of the manufacturers it is the simplest and most effective device for the purpose so far designed. The manufacturers' attention was attracted to the communication on this subject on page 306 of the September issue, and state that the contingency referred to by our correspondent could not arise with this attachment in use.

It consists of a pipe leading to the dry pipe within the boiler and communicating with the two tallow pipes. As soon as the throttle is opened an extra current of steam is admitted into the tallow pipes, which is stated to effectually overcome the back pressure and create a current of steam in the tallow pipes toward the cylinders. Thus, as soon as the drop of oil rises through the sight-feed glass it is carried at once to the wearing parts, as intended. When the throttle is closed this extra current of steam is shut off, which would prevent the accumulation of steam in the cylder.



The Tippet Locomotive Lubricator Attachment.

Four-Cylinder Compound—London and North Western Railway.

The latest locomotive designed by Mr. F. W. Webb is a four-cylinder compound known as the "Black Prince." The four-cylinder idea for a simple engine was worked out recently on that road, but the application of the compound principle to that number of cylinders is new in English practice. The heating surface is 1,400 square feet, and the working pressure is 175 pounds. The high-pressure cylinders are outside the frames and are both 15 inches in diameter. The low-pressure cylinders are between the frames, and are 14½ inches in diameter, the stroke of all cylinders being 24 inches. The Joy valve gear is used, the motion being taken from the connecting rods of the inside cylinders and rocking shafts are used to work the valves of the high-pressure cylinders, so that one motion answers for each pair of cylinders. The driving wheels are 7 feet in diameter and coupled, which is a novelty on the road. The distance between driving axle centers is 9 feet 8 inches. The truck wheels are 40 inches in diameter, and the use of a four wheel truck is to be commended. A curious practice is seen in the smokestack, which is double.

Ripper's Mean Pressure Indicator for High Speeds.

During a discussion of the subject of high-speed engines before the Institution of Mechanical Engineers (England), Prof. W. Ripper described a device invented by him for indicating such engines. It is the subject of a descriptive article in *The Engineer*, from which the following is taken:

The indicator diagram obtained from an engine running at high rotational speeds is usually a very imperfect record of what actually takes place in the engine cylinder, even with the best of indicators of the ordinary type, owing chiefly to the error introduced by the inertia of the moving parts of the indicator. This error increases as the speed increases, and for torpedo boat, electric light, and other high-speed purposes, a statement of the indicated horse-power is accepted as approximate only, and in many cases the attempt to obtain it is practically abandoned.

For many reasons the abandonment of the indicated horse-power unit of measurement is much to be regretted, and with a view to solving the problem of obtaining the mean effective pressure on the piston at all speeds, however high, the instrument here described has been devised.

The arrangement will be understood from Figs. 1 and 2. The

instrument consists of two barrels, in each of which works a piston valve over ports in the barrels. The barrels are each surrounded by a chamber, to which is connected a pressure gage for recording the pressure of the steam entering the chamber. The valves are arranged to work so that the chamber surrounding one barrel is connected continuously with the steam side of the piston only, while the chamber surrounding the other barrel is connected continuously with the exhaust side of the piston only. The mean pressure in the first chamber is the mean pressure on the steam side of the piston; and that in the second chamber is the mean pressure on the exhaust side of the piston. The pressures in the respective chambers are recorded by a pressure gage attached to each chamber; the oscillations of the finger of the gage are reduced to a minimum by throttling down the gage cock, as is now done with the gages on the receivers of compound engines, and with vacuum gages.

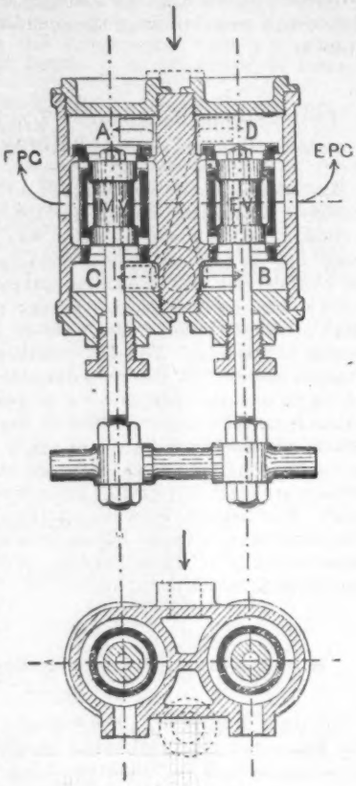


Fig. 1.

Instead of two separate gages a single differential pressure gage may be used, as shown in Fig. 2, from which the average pressure difference on the two sides of the piston may be read directly. The higher the speed of the engine the less the angle of the oscillation of the gage pointer, and the less need for throttling the gage cocks in order to read the M.E.P.

The action of the valve is as follows: M V is the main steam valve, and E V is the exhaust steam valve. The pipes leading

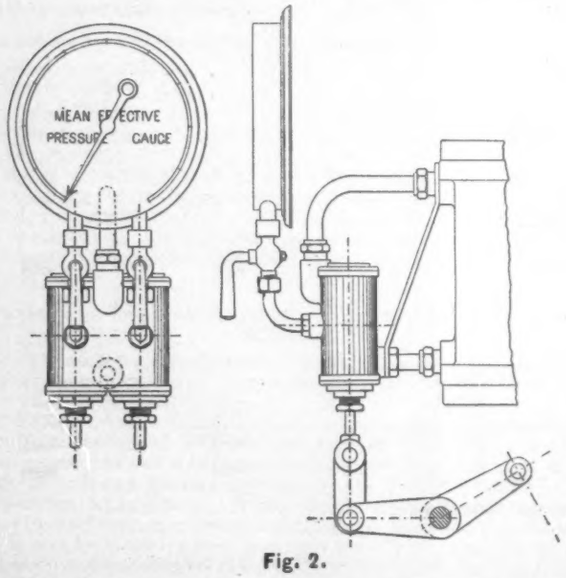


Fig. 2.

from each end of the engine cylinder are so arranged that each connects one end of one indicator barrel with the opposite end of the other barrel, as shown by the arrows. The valves are shown in mid-position, which is their correct position when the engine piston is at the end of its stroke. Both valves move together, and are worked by the same lever.

Suppose steam admitted to the top side of a vertical engine cylinder when the piston is at the top of its stroke, then admission steam enters the instrument at A and B, and steam from the exhaust side of the piston enters at C and D. The valves M V and E V now move downward—see Fig. 1—uncovering their respective ports and communicating the admission steam pressure to the forward pressure gage, F P G, while at B, the port being shut, no steam from this side of the piston can influence the exhaust pressure gage, E P G. Meanwhile, the steam from the exhaust side of the engine entered the instrument at C and D. At C the port is closed, and there is no connection with the forward pressure gage, F P G, while at D the port is open and direct communication is made between the exhaust steam and the exhaust pressure gage, E P G. In both cases the respective ports are open during the full stroke of the piston. On the return stroke the admission steam and the exhaust steam again communicate directly with their respective pressure gages throughout the whole length of the stroke.

The piston valves of the indicator are without lap, and they may be worked by a lever connected with an eccentric set at 90 degrees ahead of engine crank, or by an equivalent motion, which may be easily obtained without an eccentric in an engine having the main cranks at right angles. The instrument may be made to run continuously, as there are no working parts to get out of order; or it may be made to record a continuous mean pressure line on a continuously rotating drum.

Large vs. Small Locomotive Valves.

The distribution of steam in locomotive cylinders at high speeds is an important subject which has much to do with the economical working of the engine, and in the hope of improving the distribution recent practice has tended toward the use of very large ports and consequently very large valves. The direct object of this practice is to enable the steam to get into and out of the cylinder with as little hindrance as possible. Steam ports 20 inches long are quite commonly employed and have not been considered too long. To even suggest that it is possible to go too far in the direction of large passages must appear to many to be heretical, but in the light of some tests recently carried out on the Chicago & North Western locomotive testing plant it may be safely said that there is much that is not yet understood with regard to the action of steam in its passage between the boiler and the cylinder. These tests were conducted for the purpose of showing the comparative values of small and large ports on the proportion of the mean effective pressure to the boiler pressure and the results are very interesting.

The large Class A 8-wheel passenger engines of this road have 20-inch steam ports (the general dimensions of the engine were given on page 4 of our issue of January, 1896). The valve seats are false, and a smaller port 16 inches in length was tried on one of the engines with highly satisfactory results. Several of these large engines are now running with 16-inch Allen valves in place of the 20-inch plain valves formerly used, and they are reported to be doing very much better in actual service than the same engines did with the 20-inch plain valves. They are also better than any other engines of their class, and one of them is hauling train No. 1—the limited—from Chicago to Clinton, Ia., daily, and is always on time although the train often consists of 12 cars. No perfectly satisfactory explanation has yet been given for this fact or for its corroboration in the tests upon the testing plant, but the subject is presented because of its interest and importance, and we acknowledge the courtesy of Mr. Robert Quayle for generously supplying the information before he had been able to satisfy himself as to all its bearings.

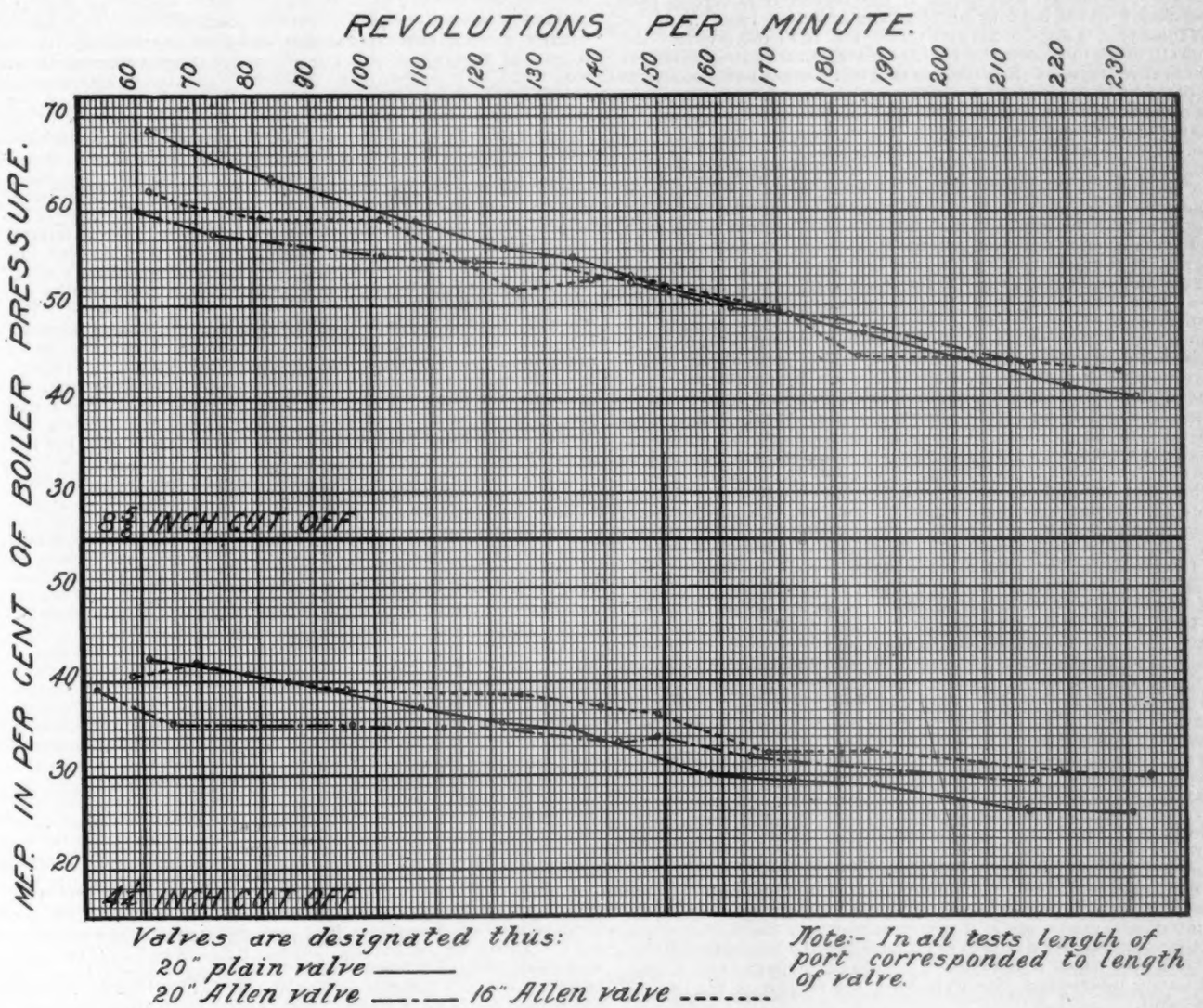
The shop tests were made on engine No. 901 and the results show the relation between the mean effective and boiler pressure at various speeds and cut-offs. The tests were run in three series, first with 20-inch plain valves, second with 20-inch Allen valves and third with 16-inch Allen valves. The results of the tests are given in detail in three pairs of diagrams. Vertical rulings indicate the point of cut-off and the speeds in revolutions per minute are shown in a curve alongside of which is the curve of mean effec-

tive pressure in percentage of boiler pressure. From the individual records the diagram shown in our illustration was prepared, the points of cut-off chosen being 4¼ and 8¾ inches as indicated in the two portions of the diagram. The three curves and key for them appear at the bottom of the engraving.

These curves show that under certain conditions of speed and cut-off the 16-inch Allen valve seems to be superior to a 20-inch Allen valve. This is a difficult matter to explain, as it appears paradoxical, but we have the testimony of the experience on the road to justify the conclusion that the tests are above criticism. It is not claimed from these tests that a 16-inch Allen valve is actually better than a 20-inch Allen valve as far as the steam pressure is concerned, but the road experience and the results on the testing plant show that the shorter valve is as good as the longer one. From an inspection of the indicator diagrams it does not appear that the back pressure is materially affected by the shortening of the port, and one reason why the 16-inch Allen valve in general does better than the 20-inch plain valve and as well as the 20-inch Allen valve may be that the area of the admission ports to the earlier cut-offs is capable of supplying all of the steam that can get through the pipes or ports.

Surface condensation might be blamed as the cause of some of the loss from large ports, and with the large amount of metal near by to conduct the heat away some may be tempted to distrust large steam pipes and passages. It must be remembered, however, that the passages in this case were not altered, the valve and valve seat alone having been changed. The difference cannot, therefore, be attributed to the action of clearance. It seems very probable that the springing of the parts of the valve gear with the large valves is to blame for some of the difference. The port openings at short cut-offs are very narrow, and slight variations in the working of the valve, motion, which are very small in themselves, would be large in proportion to the total port opening of the valve. Professor Goss has demonstrated that on the "Schenectady" with comparatively low boiler pressure the variation of the port opening was 30 per cent. of the average, which of itself would be great enough to produce an extensive change in the character of the indicator cards, and consequently in the mean effective pressure. The effect of insufficient lubrication of valves was very clearly shown by Mr. E. M. Herr in a paper read before the Western Railway Club and reproduced on page 86 of the March issue 1896 of this journal. In this connecnection it is worth noting that in September of last year Mr. Herr stated before the same club that he had frequently seen indicator cards in which the mean effective pressure was reduced one-half through the springing of the valve motion. He said: "This in my opinion may be the reason why an engine may sometimes not pull as well as a smaller engine, the larger engine, if the valves move hard, not getting enough steam into the cylinders to give enough power to move itself and the train."

The experience on the Chicago & North Western will interest our readers and if others have had similar experiences we would be glad to offer them the use of these columns to comment upon them. If it is once established that a 16-inch Allen valve will give as large a proportion of mean effective pressure as does a larger valve, either plain or with the Allen port, the advantage of the smaller valve in service will be very great as there must be a material reduction of the valve seat friction. This will not only reduce the loss of power but will also reduce the springing of the valve gear and insure the proper port opening.



Tests Comparing Large with Small Locomotive Valves.

Master Car and Locomotive Painters' Association.

The twenty-eighth annual meeting of the Master Car and Locomotive Painters' Association was held at the Hygeia Hotel, Old Point Comfort, Va., Sept. 8–10, 1897.

There was a large attendance of delegates and all the sessions of the meeting were well attended. Forty new members were received.

After receiving the address of the President, C. E. Copp (B. & M. R. R.), and the report of the Secretary and Treasurer, Robert McKeon (Erie R. R.), the reading and discussion of papers was taken up.

The first report was on "Protective Paints for Metals, Parts of Cars and Trucks." Mr. J. H. Pitard (M. & O. R. R.), a member of the committee, in writing upon this subject, said that there are no anti-rust paints; the virtue of the protective coverings rests entirely with the binding material, and in which case the oil or varnish that is non-porous and forms the most impervious coating, in order to thoroughly exclude the moisture and atmosphere will prove the most effective covering for metal. The question of a pigment is a secondary consideration and while the preference is accorded those that are of a low specific gravity and are by nature not susceptible to atmospheric influences, some of which (such, for instance, as graphite, which does not absorb the oil or binding material), while it is doubtless better for some purposes, such, for instance, as the finishing coat. He thought that some pigment, such as a mineral paint, that does absorb oil, would be preferable as a primer, as in that case the drying is greatly facilitated, which is an essential condition for durability. And yet one stubborn fact remains, which science has failed to remove and that is, that since there are no anti-rust paints, the rust and mill scale must first be removed before painting, otherwise the result will be unsatisfactory. A mere brushing of the surface with wire brushes will not suffice, but every particle of rust must first be extracted from the pores of the metal before painting, or bad results are sure to follow. Therefore, with the aid of the foregoing facts, coupled with practical experience in dealing with rust and scale, which constituting the basis of the metal-painting problem, he believed that good absorbent mineral pigment mixed with pure boiled oil for a primer, and a non-absorbent and unchangeable pigment, such as graphite, mixed with equal parts of raw linseed oil and boiled oil, would constitute a protective covering for metal which, for use under such circumstances that usually obtain in general practice, would produce results as satisfactory as reasonably could be expected.

In view of the fact that this question had been referred to the Association for consideration and report by the Master Car Builders' Association, a thorough discussion of the papers read ensued.

Mr. Ball (P. R. R.) referred to a severe exposure of samples, extending over 15 months, the samples used being red lead, small amount of litharge and raw linseed oil; another sample, straight red lead and linseed oil, without drier; another, red lead and one-half lamp black; another, red lead and three-quarters lamp black; another, mineral metallic paint, red oxide of iron; and last sample, graphite, called Mexican graphite. All except the first were mixed simply with raw linseed oil without any drier. After the exposure the red lead and litharge coating had given way in two or three spots; the red lead was intact and good for several years. The mixture of half red lead and half lamp black had several places scaled off, showing rust. The red lead and three parts lamp black was in still worse condition. The oxide of iron was completely gone. The graphite was perfect.

Mr. Putz (B. & O. S. W.) painted last year two samples with graphite and red lead, and they are now as good as when painted.

A long discussion was held as to whether the pigment, or the vehicle with which it is mixed, is the life of the paint, and it was the almost unanimous conclusion that the vehicle is the life of the paint.

Mr. Gohen, to conclude the discussion, moved that it is the sense of this Association that any first class pigment, mixed with a first-class quality of linseed oil, properly applied and cared for, will answer all purposes for all metallic parts of cars or locomotives, or structural iron, which it is proper to paint with an oil paint. This motion was unanimously adopted.

The next paper was "What methods of surfacing will give fairly good results without the use of either sandpaper or lump pumice stone for passenger cars or locomotive tenders."

In the paper by J. H. Kahler (Erie R. R.) on the next subject, "Painting Railway Equipment with Compressed Air," he said: "A great deal of fault is found in the working of different machines, owing to the spray produced filling the atmosphere with light floating mist through the shop when working indoors, but with a properly constructed device, the paint correctly prepared and sprayed with the proper pressure of air, this trouble is reduced to a minimum. For rough repaired freight cars the spray painting surpasses the brush, as the paint is blown into all bruises and roughness of surface without the usual amount of brushing by the old way. Far better work, with less material, is the result. Paint spraying has proved a success in doing freight cars, by reducing time in shop and cost of brushes; cars can be got into service quicker than by the old way with the brush, which is a gain to the railroad companies when the cars are in demand; it also proves an incentive to paint more cars, owing to the fact of the time out of service is reduced, thereby improving the appearance of the rolling stock."

The next subject, "The Cleaning of Passenger Cars and Engines at Terminals," excited much earnest discussion. Mr. Thomas Byrne (C. & O. R. R.), said "For cleaning our passenger equipment at the Richmond terminal we use a force of 20 employees, eight of whom look after the inside and 12 after the outside of the cars. They also ice and water the cars, cleaning all brass work inside and out, attend to the bedding and all interior fittings of the Pullman sleepers stopping there, and are required to keep the premises or coach yard clean and presentable at all times. We clean on an average 24 cars per day. Of these only four are cleaned daily with an oil soap which we use; the others are carefully wiped off with clean cotton waste, and present usually a very neat appearance, and then the next day four of those that were wiped on a preceding day are cleaned with the oil soap, and this is continued alternately so that at all times our equipment is looking fairly well. I have found that the best person to manage the cleaners and look after the condition of the cars is a good practical painter, one who feels a pride in his business, and is capable of managing. Another very important adjunct in the cleaning of cars at this terminal is compressed air, which we use on the interior of our cars, and find it wonderfully effective. We also use the oil soap sparingly to brighten up and renovate the headings and other interior wood work, and when carefully done it is a decided improvement upon the ancient system of dusting and wiping. The oil soap which we use is a manufactured article and is applied with a thoroughly saturated piece of cotton waste. The work to which it is applied is fairly well rubbed and is immediately wiped off with a clean piece of cotton waste, care being taken at all times to remove all traces of the soap. If properly done all stains, accumulations of smoke and other imperfections, are removed from the body of the car, leaving it as though it had just come out of the paint shop. Our engines and tenders are treated in the same manner as the passenger equipment, but not so frequently."

In the discussion Mr. Byrne stated that average cost of cleaning each car was $1.20.

Mr. Cohen offered the following:

Resolved—That it is the sense of this Association that it would be economy for all railroads to regularly and thoroughly clean all its passenger equipment, cars and locomotives, at stated intervals, with some good neutral cleaner, other than soap and water, and that this cleaning be put under the immediate supervision of the master painter of the road. Unanimously adopted.

In the paper on the "Best Method of Painting a Canvas Roof," Mr. H. L. Libby (West End Ry., Boston), said in part: "It is claimed by many that linseed oil has a tendency to rot the canvas, and that it should be well sized before the oil is applied. Possibly this is so, but it has been my practice to have the canvas set in a thick bedding composed of two-thirds lead to one-third whiting, thus forming a cement which unites the canvas so closely to the roof boards as to become part of the same. We then prime the outside or top with an oil and lead primer. Thus we have the lead before it and lead behind it, and any decay that may take place, so far as the canvas is concerned, can do but little harm. After allowing the canvas to set as long as possible and priming to harden we continue with the lead and oil."

Among the other papers presented were the following: "The Repainting of Damaged Foreign Freight Cars." "How Can the Elementary Rate-Fixing be Best Attained for Use in Establishing Piecework Prices in the Railway Paint Shop?" "The Railway Paint Shop of Modern Times." "Is it Advisable to Run to a Dead Finish the Interior of Passenger Cars?" "What is the Extra Cost?" "The Relations that Should Exist Between the Master Painter and His Superior." In audition to the foregoing there were a number of topical questions of a practical nature.

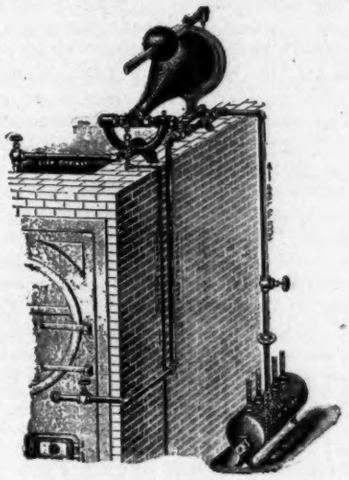
The following are the newly-elected officers: President, Charles E. Copp (B. & M. R. R.); First Vice-President, H. G. McMasters (Ill. Cent.); Second Vice-President, J. T. McCracken (Jackson & Sharp Co.); Secretary and Treasurer, Robert McKeon (Erie R. R.). The vote for the next meeting place was: St. Paul, 41; Montreal, 40.

The following supply houses were represented at the meeting: Moses Bigelow & Company, Newark, N. J.; Berry Brothers, Baltimore; Chicago Varnish Company, Chicago; Chandler & Company, New York; Chilton Manufacturing Company, New York; Detroit White Lead Works, Detroit; F. W. Devoe & C. T. Reynolds Company, New York; William Harland & Son, New York; Hildreth Varnish Company, New York; N. Z. Graves & Company, Philadelphia; J. L. McCloskey & Company, Philadelphia; Murphy Varnish Company, Newark; Patterson-Sargeant Company, Cleveland; Thresher & Company, Dayton; Valentine & Company, New York; Robert Ingham Clark & Company, New York; Valentine & Company, New York.

The Bundy Return Steam Trap.

Last month we presented an illustrated description of the Bundy gravity pump, as manufactured by the A. A. Griffing Iron Co., 66 Center street, New York. The return steam trap, which is illustrated herewith, which is manufactured by this firm, practically fulfills the duties of a pump and is more convenient for use under certain conditions than a pump. When a feed-water heater is used, which is connected with the city mains, the water from the heater may be passed into the Bundy return trap and then into the boiler. When the trap is used in this way it is necessary to employ a heater in order to heat the water so as to be handled by the trap. If it is at a temperature of 100 degrees or over the trap will put it into the boiler without difficulty, and the combination of an exhaust steam feed-water heater and a trap of this kind is a very economical one. In addition to the boiler feeding the trap will return the condensation water from drying coils or steam separators.

This trap depends on the weight of water for its operation. The water accumulates in the pear-shaped bowl, shown in the engraving, and when this is filled it settles in the frame and



The Bundy Return Steam Trap.

opens the steam valve to admit boiler steam to the trap. This closes the check valve through which the water came to the trap and equalizes the steam pressure on the trap and the boiler, whereupon the water passes into the boiler by gravity. After the discharge of the water the lightened bowl rises in the frame, closes the steam valve and opens the air valve, so that the water will again fill the bowl. The trap is open to the atmosphere while filling, which hastens the operation. The discharge of water into the boiler is from three to fifteen gallons per operation, and it is said to be as positive in its action as a pump and no expense is required for steam to operate it, beyond the amount necessary to fill the bowl of the trap, and this is condensed when the water flows into the trap, so that there is little loss of heat in its operation.

The manufacturers express wonder that a great many people do not appreciate the amount of saving that may be effected by the use of these devices. From reports received from persons using them it is clear that the subject is worthy of investigation by steam users. These manufacturers also furnish tank traps, which may be used for discharging water into a tank or sewer. The simplicity of construction of the Bundy trap is one of its best features. It is entirely free from ball floats and other mechanical complications.

Test of Riveted Joints.

The strength of riveted joints is a thing which is usually calculated, and the maximum strain which a boiler shell will stand is based upon the result of such calculation, according as the joint is of one form or another. Nothing of the kind is so conclusive, however, as actual test of the joint and a determination of the ultimate breaking strain. The results of some recent tests at the Watertown Arsenal, made for Edward Kendall & Sons, are therefore of interest.

The tests were all made on steel plate nominally ⅜ inch thick, and all the rivets used were ⅝ inch diameter, with $\frac{13}{16}$-inch drilled holes. The ordinary double-riveted joint 13.5 inches wide, with rivets pitched 3⅜ inches apart, broke when the strain was 47 per cent. of the tensile strength of the solid plate. A butt joint with double covering plates, one 10⅝ inches wide and one 5¼ inches wide, with the two rows of through rivets pitched 3⅜ inches, and the outer rows twice this distance, gave an efficiency of 57 per cent. This joint was 27 inches wide. A similar butt joint with the lower covering plate 15⅛ inches wide, and containing four rows of rivets, the two rows of through rivets being spaced 2⅛ inches apart, showed an efficiency of 78 per cent., the plate containing the joint in this case being 20 inches wide. The lengthening of the covering plates and introduction of two more rows of through rivets increased the efficiency only 0.6 per cent.

In another series of tests made with the ordinary form of triple-riveted butt joints, having one covering plate 10 inches wide and one 15.5 inches wide, the joint broke with a strain of 80 per cent. of the strength of the solid plate when the rivets were pitched 3⅜ inches, and with a strain of 83 per cent. when the pitch was 2⅛ inches. When the lower strap was lengthened to 22 inches to receive two extra rows of rivets, and the joint was tested at a temperature of 410 deg. Fahr., the efficiency was 90 per cent. on one trial and 85 per cent. on another. The rivets were pitched in these cases 2⅛ inches. When the same arrangement was tried with a pitch of 3⅜ inches, the efficiency dropped to 82.5 per cent.

These trials show that the finer pitch secures the stronger joint, and that, in either case, the triple-riveted butt joint, having double covering plates, can be made to give an efficiency of 80 to 85 per cent.—*Engineering Record.*

Locomotive Operation.*

How should a locomotive be operated to secure the most economical use of steam and fuel, speed and weight of train to be considered? In this question exist a great many points, as every act pertaining to the merits or demerits of the engineman all leads either to the economical or extravagant use of steam and fuel.

That we may have the many points more clearly in mind, let us include them all in these three great heads:

First—The skillful manipulation of the different valves and levers that serve to control this force, that it may be used to its utmost capacity when necessary, and its power also be tempered when the conditions so demand.

Second—Skillful firing.

Third—Education of enginemen.

In this subject generally occurs great diversity of opinion between theoretical and practical enginemen. For instance, from a theoretical standpoint, a locomotive, under all conditions, should be worked at shortest possible cut-off with wide-open throttle, thereby saving heat and fuel by working the steam to its fullest expansive force. However, practice has taught the engineer that this rule does not hold under all conditions; that it is not always the most economical method, where speed and weight of train are to be considered. The fact is apparent to every practical engineman that he saves a certain amount of heat by manipulating his machine in conformity with the conditions relative to speed and weight of train. Regarding the loss of power and heat by working too expansively, we can say that the loss of power has been greatly obviated by the use of the balance slide valve, but the loss of heat from condensation, by increasing the ratio of expansion beyond a certain limit, is enormous, and to overcome this loss is a problem which seems to fall of solution, except by compound expansion and skillful manipulation of the throttle and reverse lever. It is plain that any imperative rule tending to interfere with the engineman in regard to working his engine under all conditions would be expensive and injurious to the service.

If the time is fast the throttle should be opened wide when starting, but if the time is sufficient to warrant, the speed should be regulated with reverse lever, and be hooked up in accordance with speed and weight of train. At this point the engineer cannot be governed by any fixed rule, but should exercise his judgment, and not cut the lever back so far that, to use an engineman's term,

* From a committee report presented to the Traveling Engineers' Association.

"The engine will work against herself." "Working against herself" occurs when the engine ceases to maintain her speed in proportion to length of cut-off and throttle, thereby causing back pressure produced by condensation and re-evaporation. This, according to the old rule, is where working expansively is working expensively. Care should be taken not to force the engine into speed faster than necessary to make schedule time, by giving due consideration to schedule, and by making the speed as uniform as possible, avoiding an unnecessary increase of speed for the purpose of making up time before it is lost. For the well-known fact that speed increases expense is very perceptible on the coal record and comparison sheet when the expense is caused unnecessarily by bad judgment.

As the boiler is the great reservoir, the carrying of water depends greatly on its construction. The style of boiler that has the greatest capacity and will carry water highest when the engine is working at its fullest capacity is, from an economical standpoint, the most advantageous. Why? The larger the body of water being carried the less sensitive pressure will be the feed water and the greater advantage may be taken by the engineer to favor the fireman in cases of emergency. Your committee would here state that these emergency cases are of frequent occurrence to the sagacious engineer, for no matter how skillful the fireman may be, he often spoils his fire for a short period by applying coal too heavily in some part of the firebox. When this occurs the engineer, by having a large body of water, may close the injector for a few seconds, allowing the fireman to recover from the demoralizing effect, and thus regain his confidence, when otherwise he would become excited and continue to get his fire in a worse condition. The boiler being the storehouse for heat, the engineer should take advantage of every opportunity to store the heat therein, instead of allowing it to escape to the atmosphere through the safety valve. How often a fireman has been heard to remark that he could keep plenty of steam for some particular engineer, while on the same engine with some other engineer he found it difficult to make steam enough to get over the road. Where such cases as this exist it is the opinion of your committee that they are due to the carelessness or incompetency of the engineer. The first-mentioned engineer, by taking advantage of the opportunity to keep the boiler full of water when standing on the siding or at stations, stores away thousands of units of heat that he may draw from by leaving the injector closed at the start, when the engine is laboring into speed, thereby giving the fire a chance to recover from the effect of closed dampers during the stop. The careless, or second-mentioned engineer, pays no attention to the water when the engine is standing or switching, except to keep enough in the boiler to insure safety, and when ready to start pulls out with water so low that it is necessary to immediately turn the injector on full in order to keep the water within a safe limit. The fireman, noting this, will at once commence to crowd his fire in order to counteract the great drain on the boiler, and the results are the boiler loses pressure from the effect of a heavy fresh fire, and in almost every instance the fire is spoiled. When the next stop is made, and should it be for any length of time, the fireman, not wishing to be caught again with a low fire, will keep it burning furiously, resulting in a wasteful loss of fuel. The engineer should ever bear in mind that upon good pumping depends a great deal more than simply carrying enough water to prevent the burning of the crown sheet.

As a factor of economy the fireman stands equal, if not paramount, among all men in railroad service. It has been said that through his carelessness may occur an enormous loss, while through his judicious handling of the scoop dividends may be paid. To tell a fireman how and when to put the coal into the firebox in order to secure the most perfect combustion would be as impossible as to teach him how to swim by simply telling him how to do it. The art of firing must be acquired by practice and careful study. However, he should be instructed to guard against the many errors into which firemen are liable to fall.

As everything pertaining to the economical management of the locomotive depends on the training of the engineman, the effort should be equally as great in their developments as that used in bringing the locomotive up to its high grade of efficiency, Since the construction of the first locomotive, the most strenuous efforts have been made to bring it to the highest state of perfection. As to the results that have been attained the modern locomotive will demonstrate. Only within recent years has any attention been given to the development of the minds of the enginemen to bring them up to a standard corresponding to the engines they operate. Though the man operating the locomotive may be deficient in technology, though he may not have had the advantage of an academic course of training, he will, quoting the words of one of our officials who has generously taken an interest in the training and betterment of his men, "naturally turn toward knowledge, as a plant would incline toward the light." The engineman should be given every opportunity and encouragement to study the many good books and periodicals concerning his own work, and other lines, which will serve to broaden and expand his mind, thus making him economical, safe and efficient. In the training of the engineman, care should be taken that his labor be not so arduous as to affect his power of conception, for after a man's mucular powers have been overtaxed and exhausted, he will be incapacitated for any brain work necessary to qualify him a first-class engineman. The human body is only capable of a certain amount of energy, which can be used either in manual labor or developing the brain power; therefore when this energy is overtaxed in the performance of manual labor, it detracts from the energy that should go to brain work. For example, we will take a railroad president; he may be as strong, physically, as any man, but place him at braking on a local freight train for 12 hours a day, and at the end of the first few days you will find him totally exhausted, but should he continue in this capacity for any length of time the muscles that had lain dormant for years would develop and become hardened, so that he would be able to stand the work all right, while the nerve fibers that furnish the brain power would deteriorate from lack of energy in that direction. In a short time the directors would not feel disposed to go to him for information in regard to the management of the road, although they would probably be able to get some good points in unloading way freight. In the construction of all large buildings and machinery, the different parts, before being put in, are given the most rigid inspection, also after the construction is completed it is again inspected, to guard against structural weakness. This method of inspection your committee believes, from an economical standpoint, should apply to the selection of material to operate the locomotives on our railroad systems. In the hiring of men for firemen young men should be chosen who possess the natural qualifications requisite to graduate them into a higher degree. As one of our road foreman of engines, who is known for his broad and liberal views, has expressed it, "In order to handle an engine successfully it would be necessary to begin at least one generation before the engineman is born."

Petroleum Steam Engine Fuel.*

BY J. A. F. ASPINALL.

Petroleum as liquid fuel has been used much more largely than other oils, but gas tar, creosote oil, and green oil from gasworks have also been found to be very effective. The first experiments in Russia with petroleum were made in 1874, but it was not until 1883 that liquid fuel was used to any great extent in locomotives. Many experiments were tried in the direction of using atomizers or pulverizers for the purpose of making liquid fuel into the form of a spray, and among them may be mentioned those of Lentz, Artimeff, and Brandt. In 1884 a communication as to the use of liquid fuel for locomotives in Southeast Russia was made by Mr. T. Urquhart to the Institution of Mechanical Engineers, and that communication contains very full information as to the way in which the work was done.

While there is little doubt that there are great advantages in the use of petroleum refuse for raising steam, either in locomotive or other boilers, in a country like southeast Russia, where such fuel can easily be obtained, the difficulty of obtaining it at a reasonable price in this country has been a barrier to the introduction of liquid fuel as an article of considerable consumption, although its great convenience and adaptability render it a very desirable fuel if anything can be done in the way of insuring a constant supply at a moderate price. Roughly speaking, the author has found that with Lancashire coal at 9s. per ton, liquid fuel ought not to cost more than 1d. per gallon to do equivalent work. In the south of England, where coal is dearer, the conditions are somewhat more in favor of oil. The use of oil is in some respects not unlike the use of gas in a gas stove, as it can be turned off at once when it is not wanted, and started again at a moment's notice, thus preventing waste. The combustion can be made so perfect as to get rid of all smoke, and, if proper precautions are taken, no damage whatever is inflicted upon the firebox plates. These, no doubt, have to be protected in some instances by a lining of brickwork where the spray impinges upon one spot constantly, but, on the other hand, the firebox sides in a locomotive are relieved from the constant abrasion of the coal, which tends to wear down the plates between the stays and thus reduces the life of the firebox.

A liquid fuel system does not necessitate the radical alteration of a boiler, as in most cases arrangements can be made: 1st, either to

*A paper read before the Institution of Civil Engineers (England).

burn coal alone; 2d, coal and oil in such proportions as may be convenient, and 3d, oil alone.

The theoretical evaporative value of different kinds of oil compared with coal has been as under:

Theoretical Evaporative Value of Petroleum From and At 212 Degrees Fahr.

	Pounds of water per pound of fuel.
Pennsylvania heavy crude oil	21.48
Caucasian light crude oil	22.79
" heavy " "	20.85
Petroleum refuse	20.53
Good English coal	14.61

The methods of applying the oil jet in a locomotive boiler have been varied a good deal, in some cases the oil being introduced through the firehole door, and in other cases the jet being inserted below the foundation rings; so that, as Mr. T. Urquhart pointed out, he was able, where he burnt nothing but liquid fuel, to close up the firehole door altogether, thus obtaining more heating surface in his firebox.

The method adopted by Mr. Holden on the Great Eastern Railway is to put in two special openings through the firebox casing, into which are entered the oil jets.

The use of liquid fuel has not been confined to locomotives, as so far back as 1886 the Russian Government tried experiments upon two steamers built by Butz & Company, St. Petersburg, and fitted these with a type of furnace invented by Lieutenant Pashinin, and in that case it was stated that the petroleum evaporated 2¼ times as much water as the coal which they had at their disposal. Messrs. William Doxford & Sons, of Sunderland, also experimented with a torpedo boat fitted with a petroleum fuel arrangement, and there are numerous instances of recent applications. Where boilers are hand fired, or in the case of vessels in a heavy sea, it is found that the amount of labor involved can be materially reduced by the use of liquid as compared with solid fuel, and taking into account the higher evaporative efficiency of oil, there may be occasions upon which, where oil is available as fuel, a smaller boiler may be introduced with advantage, thus saving weight in vessels of the torpedo boat class. There have been instances in which oil has been used in electric light stations where sudden demands, due to fog and other causes, have made it difficult for the existing boiler plant to produce steam rapidly enough during the period of maximum output, whereas the existence of an auxiliary oil-burning plant has enabled the boilers to get through the short period of hard work without the slightest difficulty.

The most conspicuous application of oil burning in this country is that on the Great Eastern Railway, as perfected by Mr. James Holden. For such particulars as are given of work done upon that railway the author is indebted to Mr. Holden. There are on the Great Eastern Railway 37 locomotives, 13 stationary boilers, and four furnaces fitted with liquid fuel firing at present. In the case of the locomotives, the oil fuel is carried in two cylindrical tanks placed on the tender, leaving the central space perfectly free to hold coal as before. Suitable provision is made for warming the oil in these tanks in the winter. From these tanks the oil is carried by pipes to the engine foot-plate, where, after passing through the necessary valves, it is sprayed into the firebox by the injectors.

An ingenious addition to this form of injector has a pipe at the end through which heated air, heated by the waste heat in the smokebox, can be drawn through the injector, which it enters at a temperature of 300 degrees Fahr., combining with the oil as it enters the firebox. Another use which is made of this induced current where a locomotive happens to be fitted with the automatic vacuum brake is to couple the injector up with the brake pipes and make the fuel injector act as an injector for maintaining the vacuum throughout the train. Where this is done, of course, the advantage of the heated air going into the firebox is not obtained. Should oil fuel be used alone, it is only necessary to cover the firebars with a thin coating of broken firebrick so as to prevent the inrush of too much cold air.

The consumption of fuel for doing corresponding work is stated to be on the Great Eastern Railway as follows:

			Pounds per mile.
When using coal only			35.4
" " "	and oil combined	Coal	11.8
		Oil	10.5
			22 3
" " "	oil only		16.5

Once the use of oil is arranged for in considerable quantities it becomes an easier matter to supply the locomotives with their fuel than in the case of coal, as the oil can be allowed to run out of suitable tanks with great facility into the reservoirs provided upon the tender. The fuel employed on the Great Eastern Railway until recently consisted of Russian astatki, or petroleum refuse, having a specific gravity of 0.906 and an ignition temperature of 336 degrees Fahr., but the quantity imported to this country is not sufficient at present to make it readily obtainable. At present green oil is being used, and this is obtained from gas works, and has a specific gravity of 1.1 and a flash point of about 220 degrees Fahr.

The author has fitted several Lancashire & Yorkshire Railway Company's locomotives with oil-burning apparatus for use on the Liverpool Dock lines, the main object in this case being, not to economize in fuel, but to get rid of fire risk, on account of the emission of sparks, and also to avoid the production of smoke, which would have been most objectionable in passing some of the Liverpool streets. In this case Holden's injector was used, and the author has reason to believe that this course has been followed by the other railway companies who make use of the Liverpool Dock lines. In the case of the Liverpool engines, creosote oil has been largely used as being the cheapest fuel available, but gas tar has been found to give very good results.

The use of liquid fuel for the production of steam cannot be said to be in any way in the experimental stage so far as mechanical appliances are concerned; in fact, it may be called an ideal method of raising steam, the only difficulty arising being that of the question of supplying fuel at a reasonable price, a difficulty not easily surmounted in a country so far removed from the oil fields.

"Third Rail" Insulation.

A correspondent sends us the following with regard to the leakage from the "third rail" of a surface road application of electric traction:

When the N. Y., N. H. & H. R. R. first took up the third rail conductor system to replace the overhead trolley, the electrician in charge consulted a large number of electricians with varying results; most of these experts said there would be an enormous waste of current by radiation and conduction from the third rail, which has a voltage of 600. The system was tried, however, and actual tests gave the following results:

The line consisted of seven miles of third-rail conductor, a return through the T-head service rails, two miles of copper cable from the power-house to the track, with all joints copper bonded. At the first test trouble was experienced from leakage. The test was made after a storm, while the ground was wet and conditions very unfavorable, and a leakage of 2.6 amperes was discovered. It was afterward found that the truckmen had driven a spike through the white metal cable covering, and thus destroyed the insulation. The wires were found melted through, amounting to one-third the section of the cable. The second test was made on a dry evening with favorable conditions, and a circuit leakage of 0.5 amperes was found. The third test was made while the track was flooded with water for a distance of about two miles, though the motor cars continued their regular trips and no inconvenience was experienced at the station. A trolley street line took its current from the end of the third-rail conductor, and continued at its regular speed notwithstanding the fact that the third-rail was connected with the return circuit through the service rail by a water bond. The fact is that the conductors are so large and the resistance so small that there is no inducement for the current to leave the rail for a poorer conductor.

The Vibration of European Railway Carriages.

A number of tests have been made by the author to investigate the causes of vibrations of railway carriages while traveling. The carriages placed under observation were those of the Austro-Hungarian State Railway Company used in express trains of first and second class, with two axles, and with an average weight of 11.4 and 11,8 tons, and wheel base of 16 feet and 16.7 feet respectively.

The vibrations caused by defects in the permanent way or by loose coupling, being local disturbances, were not considered, and the observations were confined to carriages running on a well-kept road, properly coupled, uninfluenced by neighboring carriages, and situated in the center of the train.

The vibrations are classed in two divisions, namely:

1. Vibrations, chiefly perpendicular, which produce a quivering of the flooring and shaking of the partitions.

2. Vibrations in the transverse direction.

The vibrations in the first division are always short and quick, at the rate of about 300 per minute, become perceptible at a certain speed, and rapidly increase with the speed, and are not affected by curves. The vibrations in the second division are irregular, appearing at unequal intervals and with varying force, or they appear as more or less continuous swingings of the carriage around the perpendicular middle axis. They appear mainly on straight portions of the line, and decrease steadily on curves.

The cause of the vibrations produced under (1) is always the eccentrical position of the center of gravity of the wheel. Experiments were made, and it was found that if perpendicular suspension of the springs is employed, the main cause of these vibrations is avoided, and there is only a slight vibration in the direction of the journey.

The main cause of the vibrations produced under (2) is to be found in the usual method of fixing and suspending the springs for two and three axled carriages. In this method one portion of each spring is fixed on the axle box, the other portion through the suspension hangings to the carriage frame. The perpendicular thrusts are indeed weakened, but the horisonal side workings are very little weakened in the course of transmission through the springs. These vibrations are to a great extent overcome by the use of cross-springs, as in the case of bogie frames. The condition of the car-

riage in regard to the state of wear of its constituent parts has a very considerable influence on the vibrations in the second division, the principal causes being the following:

(*a*) Defective conditions and tension of the springs. The springs should be so flexible that they are able to transmit the sudden thrusts in long, gentle swingings, and cause a continuous easy motion of the carriage. The corresponding springs on the same axle should be perfectly similar, and all the springs of the same carriage should be built out of the same materials.

(*b*) Faulty condition and bearing of the spring supports.

(*c*) The non-existence of a sufficient conical surface on the wheel tires, always giving rise to pendulum-like vibrations.

(*d*) Unequally high buffer springs on the same side of a carriage, and an unequal amount of shrinkage in the buffer box.

(*e*) Side play of the axle journals, and play of the buffer rods.

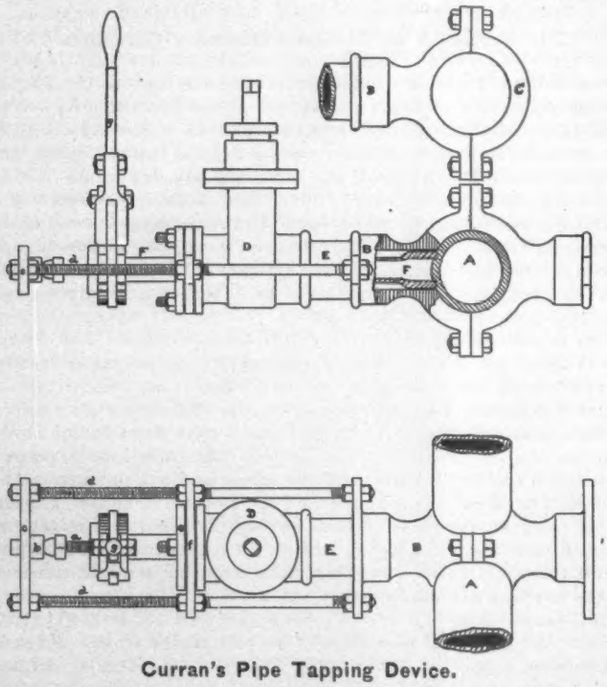
It is of great importance to find out the correct time when a carriage should be sent into the shops to undergo repair and adjustment, and although this is usually fixed by the mileage run, the author states that it is not a fair criterion to judge by, and the time should be fixed by some means of measuring the vibrations.

The author gives a detailed account of a number of experiments he made with wheels with varying counterweights in varying positions, and of the method of finding the counterweights necessary for compensating the eccentrical position of the center of gravity of the wheels, and states that the vibrations produced under (1) can be removed by the use of counterweights.—*Inst. C. E. Foreign Abstracts.*

Curran's Pipe Tapping Device.

The accompanying illustration shows the construction of a device for tapping water mains without interfering with the current therein or causing leakage during or after the operation. The engraving shows a side view partly sectioned, a plan and a portion of a modification of the device.

A represents the water-main, and *B* the branch nozzle, provided with a curved flange to fit around the main. The extremities of the flange are connected by bolts to a correspondingly curved strap, *C*, on the opposite side of the main, and a watertight joint is formed between the flange and main. *D* is a stop-valve attached directly to the nozzle *B*, or indirectly by means of a pipe *E*, as shown in the drawing. In the two principal views the strap *C* is dispensed with, and two nozzles are used, the flanges of which are bolted together, forming a complete circle around the main *A*. *F* is a hollow-boring bar, one end of which is enlarged to the size of the proposed aperture in the wall of the main, and serrated or toothed to form a cutting edge. The other end of the boring-bar is fitted with a feed screw, *a*, pointed to rest within a center, *b*, in the cross-bar *c*. The cross-bar *c* is held by means of the rod, *d*, which extend to lugs projecting from the nozzle *B*. The boring-bar, where it enters the stop-valve, is packed in order to prevent leakage around it, the packing being secured from accidental removal by means of the gland *e* and flange *f*. The boring-bar is operated through the medium of a ratchet-lever *g*.



Curran's Pipe Tapping Device.

The operation of attaching a nozzle to a water-main, and of boring the communicating aperture between them, in a manner to prevent leakage, is as follows: The nozzle, with the stop-valve, being placed in the desired position, and the strap *C* bolted thereto, the joint is formed by pouring molten lead between the surfaces of the nozzle-flange and the main. The rods *d* and the packing devices are then adjusted, and, the valve proper being raised, the boring-bar is inserted in the stop-valve, the cutting end being brought into contact with the outside of the main, and the feed-screw *a* resting within the center *b* in the crossbar *c*. An annular groove is then cut in the outside of the main. Upon the penetration of the boring-bar entirely through the side of the main, the bar is withdrawn sufficiently to allow of the closing of the valve, after which the bar may be entirely removed.

The circular piece of metal cut from the side of the main is withdrawn with the boring-bar, as it is retained within the bar by the pressure of the water in the main. It will be seen that the tool employed, not having a center point, immediately begins its cut, and does not weaken the piece removed and cause leakage from the main before the metal is entirely penetrated by the drill proper. The connection of the branch with the valve and rear bar *c*, by means of the screw-rods *d*, gives great rigidity to the whole and enables the tool to be fed up to the main in a convenient manner.

We are indebted to Mr. H. M. Etchison for the drawing and description.

EQUIPMENT AND MANUFACTURING NOTES.

The Chicago, Milwaukee & St. Paul has ordered two new trains for its Chicago-St. Paul service of the Barney & Smith Company. These trains are to be lighted by electricity and are to be up to date in all respects.

Since the announcement by the Haskell & Barker Car Company, of Michigan City, Ind., that they have orders sufficient to keep them busy for two years, there has been a great deal of speculation as to what orders they have in hand. It is impossible to give the figures, except in the case of the Chicago & Northwestern, which is building 1,000 cars at their works, but, says *The Railway Age*, the suspicion is that the company has contracts with the Northern Pacific and Great Northern roads for 5,000 cars each, making 11,000 cars under contract to be delivered within two years. The annual capacity of the Haskell & Barker Works is in the neighborhood of 6,000 finished cars, which would about accommodate the orders spoken of and justifies the bulletin posted.

The works of the Peninsula Car Company at Detroit are reported to have resumed works in all departments, the amount of work now on hand being sufficient to warrant it.

The United States Car Company is building 500 box cars at Anniston, Ala., for the Louisville & Nashville.

The Buffalo Car Manufacturing Company has an order for 100 freight cars from the Buffalo, Rochester & Pittsburgh.

The Ohio Falls Car Company is building 100 freight cars for the Memphis & Charleston and 50 for the Cincinnati, Portsmouth & Virginia.

The Harlan & Hollingsworth Company, of Wilmington, Del., has finished building 200 gondola cars of 60,000 pounds capacity for the Wilmington & Northern. They have "Little Delaware" couplers, Marden brake beams, Westinghouse air-brakes and springs by the Chas. Scott Spring Company.

The Baldwin Locomotive Works have received an order for two heavy Vauclain compound freight engines from the Chicago, Milwaukee & St. Paul. They will also build one locomotive for the Rumford Falls & Rangeley Lakes Railroad and one for the Georgia Pine Railroad in Georgia. Other orders have been received as follows: One engine for the Mobile & Birmingham, seven 10-wheel engines for the Houston, East & West Texas, two 6-wheel 60-ton switch engines for the Kansas City & Belt, four for the island of Formosa and three more for the Canadian Pacific.

The Schenectady Locomotive Works has received orders for building locomotives as follows: Ten engines for the Imperial Government Railways of Japan, two eight-wheel passenger engines for the Texas Midland.

The Pittsburgh Locomotive Works will build five freight locomotives for the Chicago & Eastern Illinois.

The Cooke Locomotive Machine Company has orders for two consolidation engines for the Oregon Short Line, and for rebuilding an 8-wheel passenger engine and changing it to the two-cylinder compound type for the Erie. This engine is to have a Wooten boiler.

The Richmond Locomotive Works have received an order for 12 consolidation engines for the Chesapeake & Ohio and one for five consolidation compound engines for the South Carolina & Georgia.

The Brooks Locomotive Works have taken an order for 20 locomotives for the Imperial Government Railways of Japan, and are now building two mogul engines for the Jalapa & Cordova Railway and one for the Climax Manufacturing Company, of Corry, Pa.

The Chicago Railway Equipment Co., of Chicago, Ill., makers of the National hollow brake beam, shipped 200 brake beams on the steamer "Columbia" from Tacoma, Wash., on Sept. 4, for the Chinese Imperial Railway.

Mr. Stephen D. Barnett has been appointed Agent for the Kalamazoo Railroad, Velocipede and Car Company in the East, with office in New York.

The Page Woven Wire Fence Company has recently improved its fencing by providing a rigid connection between the two top bars. The object of this is to prevent the appearance of sagging after persons have climbed over the fence. The addition was not needed for strength, but for appearance.

The Edward P. Allis Company, Milwaukee, has sold a 200 horsepower Corliss engine to the Chicago, Rock Island & Pacific. It has been installed and is furnishing power for the car department.

The Union Passenger Station at St. Paul will be enlarged.

The Long Island Railroad has fitted up a hospital car for use on its lines in case of accident.

Wages on the Lehigh & Hudson River that were cut last year have been advanced 5 per cent.

The Priest locomotive flanger, designed by Mr. A. F. Priest, has passed into the control of the Q & C Company, of Chicago, who will manufacture and sell it.

The Southern Pacific has apparently gone into the burning of oil for its locomotives "to stay." It is reported that seven locomotives have just been equipped with oil-burning devices.

The controlling interest in the Gibbs Electric Company, of Milwaukee, Wis., has changed hands. It has been formally announced that the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., has bought out the interest of the Gibbs Electric Company. The consideration is reported to be $50,000.

The "Compo" brakeshoe has been improved by the manufacturers, the Composite Brake Shoe Company, of Boston, in a new pattern known as "Pattern C," by the use of "shearing edges," designed to more effectively dress that portion of the wheel tire that does not come in contact with the rail. This improvement seems to be meeting with a very favorable reception.

Mr. E. Tremlett Carter, a well-known English electrical engineer, recently inspected the electrical equipment of the Baltimore & Ohio at Baltimore, as the London Underground Railway has adopted the style of motors that the Baltimore & Ohio uses in the Baltimore tunnel. At the conclusion of his inspection Mr. Carter said that is was the most complete and economically handled plant e had ever seen, and that he had never been in a tunnel that was absolutely free from smoke.

Among the roads having recently increased the working hours in its shops is the Delaware, Lackawanna & Western, which has put its Scranton shops on 10 hours per day and runs full time for the first time in eight months.

The Chicago Grain Door Company reports the following applications of its specialties: The Chicago rabbeted grain door and security lock bracket will be used in the construction of 500 Soo Line box cars building by Wells and French and 500 Canadian Pacific cars building by the Michigan Peninsula Car Company. The grain doors are to be used in building 1,000 cars for the Big Four and 1,000 cars for the C. & O. by the Pullman Company. These doors and brackets were specified for these cars and they have already been ordered from the manufacturers.

An office has been opened by the Ryan-McDonald Manufacturing Company at 78-80 Broad street, New York, in charge of Mr. N. B. Porter. The main office of the company is at 44 South srteet, Baltimore, Md. The orders for dump and flat cars, light locomotives and hoisting machinery are coming in in a very satisfactory manner, and the opening of the New York office is expected to greatly improve the business of the company. The officers report a promising outlook for business.

The Pittsburgh Testing Laboratory, Limited, Pittsburgh, has been commissioned by Major B. M. Harrod, Chief Engineer, to inspect the machinery and steel used in connection with the work of the Drainage Commission of New Orleans, La. This includes the inspection of the compound condensing engines and the centrifugal and screw pumps to be built by the E. P. Allis Company, Milwaukee, the Babcock & Wilcox boilers, the generators and motors to be furnished by the General Electric Company, and 1,500 tons of rolled steel at the Homestead Works of the Carnegie Steel Company, Limited. The Pittsburgh Testing Laboratory also inspected the steel and machinery used at the Controlling Works of the Chicago Drainage Canal near Lockport.

The B. & O. is engaged in the laying of between 300 and 400 miles of new 85-pound steel rail. This work involves a large amount of track supplies, and a communication from an officer of the company calls attention to the number of elements required. These figures are not new, but they show what track renewals mean. It takes 133.57 tons of 85-pound rail for one mile of track. Ties are laid 24 inches from center to center, making 2,640 per mile. Four spikes per tie call for 30 kegs, or 10,800 spikes weighing 6,000 pounds, or three tons. In each mile of 30-foot rail are 352 complete joints, requiring 704 splice bars and 1,408 bolts. The B. & O. uses what is known as the "Continuous Rail Joint Splice Bar," which is supposed to prevent low joints, the bane of a trackman's life.

The Miller-Knoblock Company, South Bend, Ind., announces in a recent communication that an increase in its business is to be undertaken. An electrical department is to be added under the direction of Mr. A. W. Morrell, an electrical engineer and constructor who has had years of experience in street railway motor work. It is the intention of the company to manufacture and carry in stock, ready to ship at a moment's notice, Morrell's improved assembled motor commutators for electric power motors. The fact that users of motors can procure assembled commutators for all standard motors will be appreciated. The concern will also carry in stock armature coils for all the standard motors. A complete equipment for the rewinding of armatures has been put in.

The Armstrong Manufacturing Company, of Bridgeport, Conn., and 139 Center street, New York, has recently made a number of improvements in their No. "O" Pipe Machine, ⅛ to 2 inches, and it is unquestionably the most complete and universally liked tool of its kind on the market to-day. This machine is also built to run by power as well as by hand to suit the work of large shops and mills, and it is reported that the demand for it has been very great the last few months. An illustrated description of it appears on another page.

The erecting and repair shops of the Baltimore & Ohio at Mt. Clare, in the city of Baltimore, have been completely modernized. The locomotive erecting shop has been rebuilt and is supplied with two 50-ton electric cranes which lift the heaviest locomotives and move them to any point. The compressed air appliances are of the latest pattern and the cost of making the improvements will be saved in two years, as the new machinery accelerates the work, which may be done with less expense than formerly.

The use of graphite for brazing is new, and we are informed by the Joseph Dixon Crucible Company, of Jersey City, N. J., that the work of brazing is greatly facilitated by employing this material, which is not affected by acids or alkalies, heat or cold. Braziers who have used it speak well of it. Not a little of the expense in brazing is due to the cost of removing the brass which has stuck to the metal where it is not wanted. The removal of this brass is usually attained only by patience and diligent filing. Graphite comes to the aid of the brazier in this work.

A peculiar case of breaking and entering the factory of the Magnolia Metal Company at Stirling, N. J., on the night of Aug. 6 is brought to our attention. The company referred to caused the arrest of H. G. Torrey, J. Gray Torrey and two others, and caused the issuance of a warrant for Chas. Taylor, all on a serious charge of carrying away tools and other property of the company. The affair has occasioned considerable excitement, and the daily press accounts contain statements to the effect that the object was to injure the business of the company. The Magnolia Metal Company wishes it to be known that none of the parties referred to has any connection with its business. The business relations between the company and H. G. Torrey and J. Gray Torrey were severed on April 15, 1897.

Mr. J. F. Duntley and Mr. Joseph Boyer have recently returned from a very successful business trip in England and on the continent. The pneumatic tools of the Chicago Pneumatic Tool Company were brought prominently before the naval architects of several countries by an exhibition at the Imperial Institute in London, many orders, having been taken at this exhibition from foreign governments, and altogether the trip was a very encouraging one. The reception of the pneumatic tools in France where shop wages are as low as 80 and 90 cents per day is the best evidence of their labor-saving possibilities. Mr. Duntley has sold 20 pneumatic tools to such a road. He visited many of the important shops on the continent and says that there are 60 of his pneumatic tools now in use in Russia, 60 in Austria, 40 in Germany, 80 in France and 300 in England. It must be remembered that the efforts up to date have been directed toward getting the machines introduced into railroad shops, and there is a large field yet open to them in other lines as well. It is stated that a company has been organized in England invested with the exclusive right to the sale of the tools in that country. This business is enjoying a remarkable growth from a small beginning and is an example of a good thing energetically pushed.

The Western Railway Equipment Company of St. Louis sends us a report of the sale of its specialties which indicates a very satisfactory condition of its business. The Combination Lug and St. Louis Single Track Flush Car Door have been finished for 1,000 new cars for the Missouri Pacific, for 200 new cars for the Texas Pacific, and 350 new cars for the International & Great Northern. The door referred to has also been applied during the past month to 125 cars of the Illinois Central at the Burnside shops. The Houston Pneumatic Sander, another well-known specialty controlled by this company, has become standard on the Texas Pacific and is being applied to the locomotives of that road at the rate of four per month. The Baldwin Locomotive Works have just applied the sander to three new locomotives for the same road. The New York, Ontario & Western is applying a set of sanders to an engine at the Middletown shops. The Maine Central is putting them upon all locomotives, the San Antonio & Aransas Pass has applied four each month for the past four months, the Atlantic & West Point has placed the sander on two engines, the Kansas City, Ft. Scott & Memphis has put it on six engines at Memphis, and the Pittsburg & Lake Erie has put it on an engiue at the McKees' Rocks shops. Among the other roads using the sander are the following: The Missouri Pacific on a new engine of the 999 type—and it will probably be made a standard on that road—the Baltimore & Ohio Southwestern on a locomotive at Washingon, the Texas Midland on four new engines building at the Schenectady Locomotive Works, the International and Great Northern on three locomotives during the month of August, the Atchison on two engines at Topeka, the Southern Pacific on three engines, the Kansas City, Memphis & Birmingham on five engines, the Ferro Carril Mexicano del Norte on one engine, the St. Louis Southwestern on all engines at the rate of six per month, and the St. Joe & Grand Island is also using the sander. This list speaks for itself as to the introduction of the device.

Our Directory

OF OFFICIAL CHANGES IN SEPTEMBER.

Baltimore & Ohio.—A. A. Daniels, Master Mechanic, died at Louisville, Ky., Aug. 22, at the age of 38 years.

Brainerd & Northern Minnesota.—Charles A. Pillsbury has been elected President, and J. E. Carpenter, Vice-President, both with offices at Minneapolis, Minn.

Baltimore & Annapolis.—Mr. Charles A. Coombs has retired from the position of General Manager.

Baltimore, Chesapeake & Atlantic.—Mr. T. A. Joynes has been appointed Purchasing Agent, with headquarters at Baltimore, Md.

Chicago, Peoria & St. Louis.—Mr. F. W. Huidekoper has resigned as President.

Chicago, Peoria & St. Louis.—Mr. W. E. Killen has been appointed Master Mechanic, with headquarters at Springfield, Ill. Mr. W. J. Hemphill, Superintendent of Machinery, has resigned.

Chicago, Rock Island & Pacific.—Mr. Benjamin Brewster, First Vice-President, died, Sept. 4, at the age of 67.

Cincinnati, New Orleans & Texas Pacific.—Mr. Peter H. Schreiber, Division Master Mechanic, died at his home in Chattanooga, Tenn., Sept. 9.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. H. G. Hudson has been appointed Master Mechanic, with office at Mt. Carmel, Ill.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. W. P. Orland has been appointed Master Mechanic, with office at Mattoon, Ill., vice G. S. McKee, resigned.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. R. L. Ettinger has been appointed Mechanical Engineer, with headquarters at Indianapolis, Ind.

Cleveland, Cincinnati, Chicago & St. Louis.—Mr. Mason Rickett has been appointed Master Mechanic, with headquarters at Delaware, O.

Forth Worth & Denver City.—Mr. E. W. Hayes been resigned as Superintendent of Motive Power of Machinery, and is succeeded by Mr. George K. Jackson, formerly Foreman of the shops at Wichita Falls, Tex.

Fulton County Narrow Gauge.—Mr. D. J. Thayer has been elected Vice-President in addition to his office of Secretary.

Fitchburg.—Mr. W. D. Ewing has resigned his position of General Superintendent; he is succeeded by Mr. C. L. Mayne.

Huntington & Broad Top Mountain.—Mr. Geo. F. Gage has resigned as General Manager, a position which he held for 25 years. Mr. Carl M. Gage succeeds him.

Illinois Central.—Mr. J. S. Chambers has resigned his position of Master Mechanic.

Interoceanic.—Mr. V. Sedgwick has been appointed Locomotive and Car Superintendent, with office at Puebla, Mex.

Iowa Central.—Mr. Horace J. Morse was chosen President on Sept. 3 to succeed Mr. Russell Sage, resigned.

Kansas City, Pittsburgh & Gulf.—Mr. Fred Mertsheimer has been appointed Superintendent of Motive Power and Equipment.

Kansas City, Pittsburgh & Gulf.—Mr. David Patterson has been appointed Master Mechanic, with headquarters at Shreveport, La.

Missouri Pacific.—Mr. John S. Thurman has been appointed Mechanical Engineer, with office at St. Louis, Mo.

Norfolk & Western.—James M. Barr, Vice-President, is also General Manager of this road.

Oregon R. R. & Navigation.—Mr. A. L. Mohler has been elected President.

Suffolk & Carolina.—Mr. George L. Barton was elected General Manager at a recent meeting of the Board of Directors.

Sonora.—J. A. Naugle has been appointed General Manager.

St. Louis, Peoria & Northern.—Mr. A. L. Moler has been appointed Master Mechanic, with headquarters at Springfield, Ill.

St. Louis & Hannibal.—Mr. S. Rollins has been appointed General Foreman of the shops at St. Louis.

Texarkana & Fort Smith.—Mr. W. K. Moriey has been appointed General Manager, with headquarters at Shreveport, La.

Union Pacific.—Mr. James Roberts has been appointed Master Mechanic of the Kansas division to succeed Mr. Fred Mertsheimer.

Union Pacific.—Mr. Thomas A. Davies, Master Mechanic, has changed his headquarters from Laramie, Wyo., to Ogden, Utah.

Wabash.—Mr. Geo. S. McKee has been appointed Master Mechanic, with headquarters at Moberly, Mo.